UNITED STATES OF AMERICA
DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

In re: **Proposed Waiver and Regulations Governing the Taking of Eastern North Pacific Gray Whales by the Makah Indian Tribe**	) Administrative Law Judge) Hon George J. Jordan) Docket No. 19-NMFS-0001)) RIN: 0648-BI58 and) RIN: 0648-XG584

DECLARATION OF DR. SHANNON BETTRIDGE

I, Dr. Shannon Bettridge, declare as follows:

QUALIFICATIONS and EXPERTISE

1. I have worked with the National Marine Fisheries Service (NMFS), which is part of the National Oceanic and Atmospheric Administration (NOAA), since April, 2006. I am currently the Chief of the Marine Mammal and Sea Turtle Conservation Division in the Office of Protected Resources in Silver Spring, Maryland. I have held this position since April, 2018. Prior to assuming the duties of my current position, I held a number of positions within the Office of Protected Resources, NMFS, including fisheries biologist, National Marine Mammal Scientific Review Group Coordinator, National Marine Mammal Stock Assessment Report Coordinator, and Acting Division Chief and Acting Deputy Division Chief of the Marine Mammal and Sea Turtle Conservation Division. Through my work at NOAA, I have gained extensive experience and expertise in the life history of large whales and the type and associated impacts of human interactions with large whales. I am also familiar with the requirements of the Marine Mammal Protection Act (MMPA, or Act), 16 U.S.C. §§ 1361 *et seq.*, and with the responsibilities delegated to NMFS under the MMPA. Since 2010, my responsibilities

have included working as a member of the NMFS team responding to the Makah Tribe's request seeking authorization to hunt Eastern North Pacific (ENP) gray whales in the Tribe's usual and accustomed fishing area (U&A).

2. I hold a Ph.D. in Marine Affairs, a Master of Arts in Marine Affairs, and a Bachelor of Arts in Environmental Public Policy. My academic and professional publications are described in my attached Curriculum Vitae. NMFS Ex. 2-1.[1]

3. Prior to my current position, I worked as the NMFS National Marine Mammal Stock Assessment Report Coordinator. One of my principal duties in that role was compilation and oversight of the annual Stock Assessment Reports issued by NMFS pursuant to Section 117 of the MMPA, 16 U.S.C. § 1386. I currently supervise the NMFS National Marine Mammal Stock Assessment Report Coordinator. Those positions have allowed me to develop extensive experience and expertise in the review, evaluation, and identification of marine mammal stock structure and status under the MMPA, and with the requirements of MMPA, particularly Section 117.

<u>STOCK ASSESSMENT REPORTS—BACKGROUND</u>

4. Section 117 of the MMPA, added to the Act in 1994, directs NMFS to prepare a stock assessment report (SAR) for each marine mammal stock that occurs in U.S. waters. 16 U.S.C. § 1386(a). The MMPA defines a "population stock" or "stock" as "a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature." 16 U.S.C. § 1362(11).

[1] NMFS's exhibits are labeled as follows: "NMFS Ex. 1-XX" for exhibits attached to the Declaration of Chris Yates; "NMFS Ex. 2-XX" for exhibits attached to the Declaration of Dr. Shannon Bettridge; "NMFS Ex. 3-XX" for exhibits attached to the Declaration of Dr. David Weller; and, "NMFS Ex. 4-XX" for exhibits attached to the Declaration of Dr. Jeffrey Moore.

5. Section 117 of the MMPA establishes the framework through which NMFS identifies marine mammal stocks and assesses their status. 16 U.S.C. § 1386. The section also details SAR content and procedures for issuing them. The statute defines the following terms most pertinent to my declaration at 16 U.S.C. § 1362:

- "optimum sustainable population," or OSP, is "with respect to any population stock, the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element";
- "potential biological removal level," or PBR, "means the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its [OSP]. The potential biological removal level is the product of the following factors: (A) `The minimum population estimate of the stock. (B) One-half the maximum theoretical or estimated net productivity rate of the stock at a small population size. (C) A recovery factor of between 0.1 and 1.0";
- "minimum population estimate," or Nmin, "means an estimate of the number of animals in a stock that (A) is based on the best available scientific information on abundance, incorporating the precision and variability associated with such information; and (B) provides reasonable assurance that the stock size is equal to or greater than the estimate";
- a "strategic stock" is a "marine mammal stock (A) for which the level of direct human-caused mortality exceeds the [PBR] level; (B) which . . . is

declining and is likely to be listed as a threatened species . . .within the forseeable future; or (C) which is listed as threatened species or endangered species under the Endangered Species Act . . . , or is designated as depleted" under the MMPA;

- "depleted" means any case in which the Secretary or a State, after consultation with requisite bodies, "determines that a species or population stock is below its [OSP]; . . . " or when "a species or population stock is listed as an endangered species or threatened species under the Endangered Species Act . . . ."

6. Section 117(a) of the MMPA requires NMFS to prepare SARs in consultation with the appropriate regional scientific review group (discussed below). 16 U.S.C. § 1386(a). SARs must be based on the best scientific information available and must, among other things: "(1) describe the geographic range of the affected stock . . ."; (2) identify the stock's "minimum population estimate, current and maximum net productivity rates, and current population trend . . . ; (3) estimate the annual human-caused mortality [(HCM)] and serious injury of the stock by source, and, for a strategic stock, other factors that may be causing their decline or impeding recovery of a stock . . . ; (4) describe commercial fisheries that interact with the stock . . . ; (5) categorize the status of the stock as one that either . . . has a level of [HCM] and serious injury that is not likely to cause the stock to be reduced below its [OSP or] . . . is a strategic stock . . . ; and (6) estimate [PBR] level for the stock, describing the information used to calculate [the PBR], including the recovery factor." 16 U.S.C. § 1386(a). The use of PBR has been thoroughly reviewed by NMFS scientists and others involved in marine mammal

management. *See*, *e.g.*, NMFS Ex. 2-2 (Wade 1998[2]); NMFS Ex. 2-3 (Taylor *et al*. 2000[3]); NMFS Ex. 2-4 (National Research Council 2005[4]). Draft SARs are made available for public review and comment for a period of 90 days.16 U.S.C. § 1386(b)(1). The Marine Mammal Commission typically reviews and comments upon the draft reports during this comment period.

7. MMPA section 117(c) requires that NMFS review SARs at least annually for strategic stocks and stocks for which there is significant new information, and at least once every three years for other stocks. 16 U.S.C. § 1386(c). If that review indicates that the subject stock's status has changed or can be more accurately determined, then NMFS must revise the SAR accordingly. 16 U.S.C. § 1386(c)(2). The number of SARs actually revised in a given year varies depending on the number of stocks for which there is significant new status information; if NMFS reviews a SAR and concludes there is no significant new information to add, it will not revise the report at that time.

8. To support the stock review process, MMPA Section 117(d) directed the Secretary of Commerce to establish three regional scientific review groups (SRGs) to represent Alaska, the Pacific Coast (including Hawaii), and the Atlantic Coast (including the Gulf of Mexico). 16 U.S.C. § 1386(d). The SRGs consist of individuals with marine mammal expertise who represent a variety of viewpoints. *Id.* The proceedings of SRG meetings, along with SRG recommendations to NMFS and the agency responses are made available online: https://www.fisheries.noaa.gov/national/marine-mammal-

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[2] Wade, P. R. 1998. Calculating limits to the allowable human-caused mortality of cetaceans and pinnipeds. Marine Mammal Science 14(1):1-37.

[3] Taylor, B.L., Wade, P.R., D.P. DeMaster, and J. Barlow. Incorporating Uncertainty into Management Models for Marine Mammals. Conservation Biology 14(5):1243-1252.

[4] NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES, MARINE MAMMAL POPULATIONS AND OCEAN NOISE CHAP. 4 (2005).

protection/scientific-review-groups.[5] The Alaska SRG reviewed the status of the ENP gray whale stock until 2012, when the Pacific SRG took over that responsibility. *See* NMFS Ex. 2-5 (Carretta *et al*. 2013[6]). The Pacific SRG included the WNP gray whale stock for the first time in its 2014 review. *See* NMFS Ex. 2-6 (Carretta *et al*. 2015[7]).

9. Several NMFS offices participate in the development, review, and publication of SARs (including revisions). Data collection, analysis, and interpretation are conducted through marine mammal research programs at each of the six regionally located NMFS Science Centers. SARs, and research papers supporting SARs developed within NMFS, are peer-reviewed within the Science Centers, by the SRGs, and may also be submitted for review by other qualified experts, such as editorial boards for scientific journals, or the International Whaling Commission (IWC) Scientific Committee.

10. As part of NMFS's internal review, draft SARs are reviewed by: me and my staff within the NMFS Office of Protected Resources, NMFS Regional Office Staff, NMFS Office of Science and Technology staff, NOAA General Counsel, Fisheries and Protected Resources Section, and NMFS Leadership before being approved in draft form for publication in the *Federal Register* and made available for public review and comment. My office also reviews and coordinates development of responses to any comments received and updates to the SARs based on those comments, as appropriate, in cooperation with the appropriate Science Centers and Regional Offices. Then, after considering the best available scientific information, the advice of the appropriate

[5] Last visited April 1, 2019.

[6] Carretta, J., and 15 co-authors. 2013. U.S. Pacific Marine Mammal Stock Assessments: 2012. NOAA-TM-NMFS-SWFSC-504.

[7] Carretta, J., and 15 co-authors. 2015. U.S. Pacific Marine Mammal Stock Assessments: 2014. NOAA-TM-NMFS-SWFSC-549.

regional SRG, and all public comments and responses, and after a final review and approval by me, NOAA General Counsel, and NMFS Leadership, and finally the NMFS Assistant Administrator, NMFS finalizes the SARs and, under 16 U.S.C. § 1386(b)(3), submits a Notice of Availability in the *Federal Register*. Additionally, the SARs receive internal formatting review and are published as Technical Memoranda as Science Center publications, concurrent with the *Federal Register* notice of availability. Draft and final SARs are available, often within regional compendiums, on the NMFS website at: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments.[8]

11. Because of the rigorous review process, SARs take many months to finalize. As a result, most SARs are published at least one year after the reports' reference years, sometimes causing confusion between the citation year, and the data year. For example, the most recent SARs for both the Eastern North Pacific and Western North Pacific stocks of gray whales are cited as Carretta *et al*. 2017,[9] but are commonly referred to as the 2016 ENP or WNP SAR for these stocks. *See* NMFS Ex. 2-7.

12. In my role as supervisor of the NMFS National Marine Mammal Stock Assessment Report Coordinator, I oversee coordination among the six NMFS Science Centers, five Regional Offices, three SRGs, and the NMFS Offices of Protected Resources and Science and Technology to ensure the ongoing review and assessment of approximately 333 marine mammal stocks, including approximately: 116 stocks in the Atlantic Ocean and Gulf of Mexico; 165 stocks along the Pacific Coast of the continental

[8] Last visited April 1, 2019.

[9] Carretta, J., and 15 co-authors. 2017. U.S. Pacific Marine Mammal Stock Assessments: 2016. NOAA-TM-NMFS-SWFSC-577.

United States and Hawaii; and 52 stocks in Alaska and the North Pacific Ocean. The number of stocks, and therefore SARs, may vary from year to year because stock delineation is subject to change.

STOCK IDENTIFICATION—BACKGROUND

13. To assist in the consistent, nation-wide implementation of Section 117, NMFS and United States Fish and Wildlife Service have held a series of workshops, beginning in 1994, and developed guidelines, known as the *Guidelines for Preparing Stock Assessment Reports Pursuant to the 1994 Amendments to the MMPA* (also known as the Guidelines for Assessing Marine Mammal Stocks, or GAMMS). NMFS issued the first GAMMS in 1995. To account for advances in science, NMFS updated and revised the GAMMS in 1996, 2005, and most recently in 2016. Each update was undertaken following a workshop by scientific experts and consultation with the Marine Mammal Commission. The GAMMS, including all updates, were made available for public review and comment and are available online at: https://www.fisheries.noaa.gov/national/marine-mammal-protection/guidelines-assessing-marine-mammal-stocks.[10] NMFS adopted the most recent 2016 GAMMS as NMFS Policy Directive 02-204-01 (February 22, 2016) (NMFS 2016), which it considers when preparing SARs. NMFS Ex. 2-8.[11]

GRAY WHALE STOCK STRUCTURE

14. NMFS issued the first SAR for gray whales in 1995. 60 Fed. Reg. 44,308-01 (Aug. 25, 1995). That SAR identified the Eastern North Pacific (ENP) population of

[10] Last visited April 1, 2019.

[11] NMFS 2016. Guidelines for Preparing Stock Assessment Reports Pursuant to the 1994 Amendments to the MMPA. NMFS Instruction 02-204-01, Feb. 22, 2016.

gray whales as an MMPA stock, whose range spanned the West Coast of the United States from Baja California to the Bering, Chukchi, and Beaufort Seas. At that time, NMFS recognized a second population of gray whales—the Western North Pacific (WNP) population—as a "species" protected under the Endangered Species Act, but NMFS did not prepare a SAR for or identify the WNP population as a stock under the MMPA, because MMPA section 117 applies only to marine mammals found in U.S. waters. The information available at the time indicated that the WNP population did not occur in U.S. waters.

15. Beginning in 2010, new information became available regarding a group of ENP whales known to summer off the coasts of Oregon, Washington, and Vancouver Island, B.C., rather than completing the northward migration to the Chukchi, Bering, and Beaufort Seas. NMFS Ex. 3-2 at 9 (Weller *et al.* 2013[12]). Also in 2010, the IWC designated animals that spend the summer and autumn feeding in coastal waters of the Pacific coast of North America from California to southeast Alaska as the "Pacific Coast Feeding Group" or PCFG, and later refined the definition of the group for purposes of abundance estimation as animals sighted more than once between 41°N lat. and 52°N lat. from June 1 to November 30. NMFS Ex. 2-7 at 8 (Carretta *et al*. 2017); *see also* NMFS Ex. 2-9 (IWC 2012[13]). NMFS has adopted the IWC's PCFG terminology. *See, e.g.*, NMFS Ex. 2-7 (Carretta *et al*. 2017). In 2012, NMFS convened a task force of agency experts to evaluate the new information to determine the possibility of finer gray whale

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[12] Weller, D. W., and 7 co-authors. 2013. Report of the National Marine Fisheries Service gray whale stock identification workshop. March 2013. NOAA Technical memorandum NOAA-TM-NMFS-SWFSC-507.

[13] IWC 2012. Chair's Report of the 64th Annual Meeting of the International Whaling Commission, 2-6 July 2012.

stock structure in U.S. waters, including whether the PCFG might meet the MMPA's definition of a separate stock. I was a member of that task force. The overarching objective of the task force was to provide an objective, scientific evaluation of gray whale stock structure as defined under the MMPA and guided by the GAMMS.

16. In 2013, the task force issued its report titled *Report of the National Marine Fisheries Service Gray Whale Stock Identification Workshop*. NMFS Ex. 3-2 (Weller *et al*. 2013). Dr. Weller describes the contents of that Report in his Declaration. *See* Weller Decl. ¶¶ 7, 19–20, 27. The Task Force Report concluded, among other things, that PCFG whales interbreed with other ENP whales, including potentially other PCFG whales. NMFS Ex. 3-2 at 44 (Weller *et al*. 2013). However, upon review of results from photo-identification, genetics, tagging, and other studies within the context of the GAMMS, the task force found that "there remains a substantial level of uncertainty in the strength of the lines of evidence supporting demographic independence of the PCFG [from the ENP]." *Id.* at 47. Because the evidence did not support designating the PCFG as a separate stock, NMFS has retained the existing designation for the ENP stock as including the PCFG, and continued to evaluate PCFG whales as part of the ENP stock. *See*, *e.g.*, NMFS Ex. 2-6 (Carretta *et al*. 2015).

17. Also in 2010, information became available demonstrating that some WNP whales migrate through U.S. waters. As explained in more detail in the Weller Declaration, the task force reviewed this information along with genetic information showing mitochondrial DNA and nuclear DNA differentiation between the WNP and ENP populations, and advised that the WNP stock should be recognized as a population stock pursuant to the GAMMS and the MMPA. NMFS Ex. 3-2 at 48 (Weller *et al*. 2013).

In response to the Task Force Report, NMFS developed a SAR for the WNP stock of gray whales. NMFS Ex. 2-7 at 20 (Carretta *et al*. 2017).

GRAY WHALE SARS

18. The Task Force Report informed the 2014 and subsequent SARs for ENP and WNP gray whales. With regard to the ENP stock and associated PCFG, and consistent with the Task Force Report, the 2014 and subsequent SARs continue to recognize single stock structure for the ENP gray whale, representing NMFS's determination on this issue.

19. The 2016 SAR for ENP gray whales, published in 2017, estimates ENP gray whale abundance at 20,990 animals, with a PBR of 624 and human-caused mortality and serious injury of 133 ENP gray whales per year on average. NMFS Ex. 2-7 at 9–15 (Carretta *et al*. 2017).

20. Although the 2014 SAR confirmed that the ENP whales, including the PCFG, was a single stock, it did acknowledge that the PCFG appears to be a feeding aggregation that may warrant consideration as an independent stock in the future. NMFS Ex. 2-6 (Carretta *et al*. 2015). The term "feeding aggregation" is used by biologists in the scientific literature to describe concentrations of whales that forage in a specific area. NMFS's use of the term is not intended to signify that such whales constitute a "stock" as that term is defined under the MMPA (i.e., "a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature" 16 U.S.C. § 1362(11)) .

21. Although NMFS does not recognize the PCFG as an MMPA stock or prospective stock, the 2016 SARs for the ENP stock include estimates of PCFG

abundance, human-caused mortality, and PBR for informational purposes. As reported in the 2016 SAR, abundance estimates for PCFG whales have been relatively stable since 2003, and most recently estimated at 209, with a minimum abundance of 197. NMFS Ex. 2-7 at 10 (Carretta *et al*. 2017); *see also* NMFS Ex. 3-33 at 11 (Calambokidis *et al*. 2017[14]) (discussing the PCFG as fairly stable since 2002). As explained above and as would be typical for normal PBR calculations, the ENP SAR uses this minimum abundance to calculate an informational PBR for PCFG whales of 3.1 whales per year. NMFS Ex. 2-7 at 11 (Carretta *et al*. 2017). The SAR also identifies an average total annual human-caused mortality and serious injury of 0.25 PCFG gray whales per year. *Id.* at 15. The SAR does not estimate a separate PBR for U.S.-only waters.

22. With regard to the WNP whales, as noted above NMFS has recognized WNP gray whales as a separate MMPA stock, consistent with the Task Force Report. As noted above, the most recent SAR for the WNP stock is dated 2016. *Id.* at 20. That SAR describes the point estimate of WNP gray whale abundance as 140 individuals with an annual rate of increase at 3.3 percent and a PBR in U.S. waters of 0.06 whales per year or approximately 1 whale every 17 years (if abundance and other parameters in the PBR equation remained constant over that time period). *Id.* at 21. There is no quantified estimate of human-caused mortality for this stock and no human-caused mortality has been observed in U.S. waters. *Id.* at 22.

[14] Calambokidis, J., Laake, J., and A. Perez. 2017. Updated analysis of abundance and population structure of seasonal gray whales in the Pacific Northwest, 1996–2015. Paper SC/A17/GW/05 presented to the International Whaling Commission.

UPCOMING GRAY WHALE SARS

23. NMFS is in the process of updating the ENP gray whale SAR, and recently released a draft 2018 SAR for public comment. NMFS Ex. 2-10 (Carretta *et al.* 2018[15]); 83 Fed. Reg. 47,131 (Sept. 18, 2018). The update included newly published information on abundance and PBR of the ENP stock. The updated draft 2018 SAR includes the updated abundance estimate from Durban *et al*. 2017 of 26,960 whales. NMFS Ex. 3-42 at 4 (Durban *et al*. 2017[16]). That abundance level results in a PBR of 801 whales. Human-caused mortality and serious injury in the draft SAR is 138 and thus does not exceed PBR. This mortality estimate takes into account all known sources, including fishery entanglement, subsistence/native harvest and ship-strikes.

24. The revised draft 2018 ENP gray whale SAR includes data, for informational purposes, regarding the PCFG. The revised draft 2018 SAR used the most recent (2015) abundance estimate from Calambokidis 2017 which is 243 whales, and identified a minimum population estimate for PCFG whales of 227 animals. NMFS Ex. 2-10 at 5–6 (Carretta *et al.* 2018) (citing NMFS Ex. 3-33 (Calambokidis 2017). This results in a PBR, for informational purposes, of about 3.5 PCFG whales. The revised draft 2018 SAR continues to conclude ENP gray whales are a single stock, since no new evidence has been developed to suggest that the PCFG is a separate stock. During its most recent review of the NMFS draft SAR for ENP gray whales, the Pacific SRG recommended that NMFS reconsider the characteristics and status of the PCFG and

[15] Carretta, J., and 15 co-authors. 2018. U.S. Pacific Draft Marine Mammal Stock Assessments.

[16] Durban, J.W., D.W. Weller, and W.L. Perryman. 2017. Gray whale abundance estimates from shore-based counts off California in 2014/15 and 2015/16. Paper SC/A17/GW/06 presented to the International Whaling Commission Scientific Committee.

whether it should be recognized and managed as a full stock. NMFS replied that it does not believe that currently available information supports classifying the PCFG as a stock under the MMPA. NMFS Ex. 2-11 at 11–12 (Wieting 2018[17]).

I declare, under penalty of perjury under the laws of the United States, that the foregoing is true and correct to the best of my knowledge, information, and belief.

BETTRIDGE.SHANNON.O M.1365827920 Digitally signed by BETTRIDGE.SHANNON.O M.1365827920 Date: 2019.04.01 16:55:30 -04'00'

Shannon Bettridge

Dated: ________________________

[17] Letter from Donna S. Wieting, Director, NOAA Office of Protected Resources to John Calambokidis, Acting Chair, Pacific Scientific Review Group (Aug. 27, 2018).

DECLARATION OF DR. SHANNON BETTRIDGE
<u>EXHIBIT LIST</u>

2-1. Curriculum Vitae (CV)
2-2. Wade, P. R. 1998. Calculating limits to the allowable human-caused mortality of cetaceans and pinnipeds. Marine Mammal Science 14(1):1-37.
2-3. Taylor, B.L., Wade, P.R., D.P. DeMaster, and J. Barlow. Incorporating Uncertainty into Management Models for Marine Mammals. Conservation Biology 14(5):1243-1252.
2-4. NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES, MARINE MAMMAL POPULATIONS AND OCEAN NOISE CHAP. 4 (2005).
2-5. Carretta, J., and 15 co-authors. 2013. U.S. Pacific Marine Mammal Stock Assessments: 2012. NOAA-TM-NMFS-SWFSC-504.
2-6. Carretta, J., and 15 co-authors. 2015. U.S. Pacific Marine Mammal Stock Assessments: 2014. NOAA-TM-NMFS-SWFSC-549.
2-7. Carretta, J., and 15 co-authors. 2017. U.S. Pacific Marine Mammal Stock Assessments: 2016. NOAA-TM-NMFS-SWFSC-577.
2-8. NMFS. 2016. Guidelines for Preparing Stock Assessment Reports Pursuant to the 1994 Amendments to the MMPA. NMFS Instruction 02-204-01, Feb. 22, 2016.
2-9. IWC 2012. Chair's Report of the 64th Annual Meeting of the International Whaling Commission, 2-6 July 2012.
2-10. Carretta, J., and 15 co-authors. 2018. U.S. Pacific Draft Marine Mammal Stock Assessments: 2018.
2-11. Letter from Donna S. Wieting, Director, NOAA Office of Protected Resources to John Calambokidis, Acting Chair, Pacific Scientific Review Group (Aug. 27, 2018).

SHANNON BETTRIDGE, Ph.D.
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PROFILE

Natural resource manager with specialized expertise in marine mammal and endangered species conservation, fisheries management, and protected species policy development and implementation. Extensive working knowledge of marine mammal biology and legal mandates under the Marine Mammal Protection Act (MMPA), Endangered Species Act (ESA), Magnuson-Stevens Fishery and Conservation Management Act (MSA), and National Environmental Policy Act (NEPA). Experience with federal, regional, and state fisheries data collection and analysis, including assessing the impact of marine mammal conservation programs on the human and natural environments.

PROFESSIONAL EXPERIENCE

Division Chief April 2018 - present
Acting Division Chief June 2017 – November 2017
Acting Deputy Division Chief June 2016 – May 2017

NOAA Fisheries Service, Office of Protected Resources
Marine Mammal and Sea Turtle Conservation Division
1315 East-West Highway, Silver Spring, MD 20910

As Chief of the Marine Mammal and Sea Turtle Conservation Division, I manage and direct the Division in developing and implementing natural resource conservation and management programs and regulations under the MMPA and ESA to protect and conserve living marine resources and their habitats. This includes planning the work of the program teams, ensuring that it is aligned with the Office's and Agency's priorities, and ensuring that resources are available for staff to accomplish projects and tasks. I work with the marine mammal and sea turtle teams to develop priorities and goals. I am responsible for planning, executing, and overseeing multiple budget lines, as well as the time, attendance, travel, and performance for the 20 staff under my supervision. I review staff performance, develop performance standards, monitor, and evaluate staff performance. I provide mentorship and supervisory support to staff so that they are able to perform at their highest level, including encouraging training and professional development. During my detail as Acting Deputy Division Chief, I received the NOAA Fisheries Employee of the Year award for the Leadership/Supervisor category.

Fishery Biologist December 2017 – March 2018
December 2012 – May 2016

NOAA Fisheries Service, Office of Protected Resources
Marine Mammal and Sea Turtle Conservation Division
1315 East-West Highway, Silver Spring, MD 20910

As a fishery biologist in the Marine Mammal and Sea Turtle Conservation Division, I specialized in marine mammal recovery, with an emphasis on implementation and interpretation of the MMPA. This position required extensive knowledge of the ESA and NEPA, as well as marine mammal population assessment and endangered species recovery. In this position I developed, reviewed, and revised MMPA guidelines, criteria, and procedures to guide the agency in the management of marine mammal programs, and developed rulemakings under the MMPA. This frequently involved formulating natural resource policy recommendations to ensure legal compliance with the MMPA and ESA. I identified, assessed, and resolved natural resource management issues affecting protected species and involving and communicating with local, state, Tribal and Federal governments, fishing groups, non-governmental organizations, and/or the general public. I represented the Office of Protected Resources and NOAA Fisheries at the national and regional level on technical matters regarding stock assessment coordination and recovery of protected marine mammal species and populations. I presented agency policies, positions, and interests to representatives of industry, non-governmental organizations, Federal, state, local and Tribal governments, and the general public. I regularly developed and provided briefings on recommendations and technical information as well as agency policies, positions, and positions to senior NOAA leadership, and on occasion to Hill staff and representatives. I was a member of a team that received a Department of Commerce Gold Medal for developing the ESA listing rule for humpback whales.

As the National Coordinator of marine mammal stock assessment reports and National Coordinator of the Scientific Review Group, I oversaw the marine mammal stock assessment and recovery programs for the NOAA Fisheries Office of Protected Resources and represented the agency's policies and positions. I reviewed and coordinated publication of stock assessment reports and other complex technical scientific documents to ensure statutory compliance and consistency with agency requirements, as well as provided guidance to authors. This required an understanding of population biology and quantitative methods used to evaluate population dynamics and demographic parameters of marine mammals.

Fishery Biologist April 2006 – November 2012

NOAA Fisheries Service, Office of Protected Resources
Marine Mammal and Sea Turtle Conservation Division
1315 East-West Highway, Silver Spring, MD 20910

As coordinator of large whale recovery programs, I contributed to the development and implementation of programs and regulations to reduce threats to endangered large whales, including ship strike reduction, ESA recovery planning, and fisheries bycatch mitigation to ensure compliance with the MMPA and ESA. Duties included regular synthesis, evaluation, and presentation of technical scientific data and natural resource issues in the form of briefings for leadership and presentations to state and federal agencies, industry groups, environmental groups, non-governmental groups, academic audiences, and the general public. I chaired the global ESA status review of humpback whales, which provided the basis for a rulemaking to revise the ESA listing for humpback whales. Ship strike reduction efforts included development, implementation, monitoring, and analysis of a *Final Rule to Implement Speed Restrictions to Reduce the Threat of Ship Collisions with North Atlantic Right Whales*, promulgated under MMPA and ESA. I coordinated NEPA efforts to assess the impact of the regulations on the natural and human environments, including drafting sections of the NEPA environmental impact statement and assisting with responding to public comments on the review. I also reviewed NEPA environmental assessments and impact analyses related to Federal protected species actions. Other ESA duties included drafting, reviewing, and supervising development of marine mammal recovery plans, 5-year reviews, and status reviews to address natural and anthropogenic threats to endangered marine species. These plans and reviews outline actions needed for the management, protection, and/or restoration of aquatic habitats to recover endangered marine species. In this role I also assisted with planning and execution of the large whale budget of approximately $1 million. I was a member of a team that received a Department of Commerce Silver Medal for developing a program to enforce the ship speed rule.

ACCSP Program Coordinator August 2002 – March 2006

Atlantic States Marine Fisheries Commission
Atlantic Coastal Cooperative Statistics Program
1444 Eye Street, NW, Washington, D.C. 20005

I coordinated and led scientific committee activities including the development of technical program documents, issue and policy papers, strategic plans, implementation plans, and annual operations plans. Specific duties included: Overall support, coordination, and documentation of technical committee work, including the Biological Review Panel, Bycatch Committee, and Commercial and Recreational Technical Committees; coordinated the activities of the Bycatch Committee to ensure compliance with the MMPA, ESA, and interstate fishery management plans; compiled relevant materials for technical committee meetings; assisted the Director with development of policy documents and presentations; provided staff assistance to State agency Partners as required to assist in the implementation of Program Standards; and assisted in the annual funding process. Served as acting Director as needed.

Instructor and Doctoral Student September 2000 – May 2005

The University of Rhode Island, Department of Marine Affairs
Upper College Road, Kingston, R.I. 02881

My Ph.D. research involved analyzing and comparing the legislative mandates of the MMPA, ESA, and NEPA, as applied to the implementation of the Atlantic Large Whale Take Reduction Plan. This entailed interviewing Federal, state, and local government officials, and commercial fishermen to assess the effects of the management plan on fishing operations, and conducting statistical analyses of the data I collected. It also included attending Take Reduction Team meetings, and developing a strong working knowledge of section 118 of the MMPA and its mandates to manage commercial fisheries that interact with marine mammals.

Fishing Business Owner, Operator, and Manager September 1995-July 2002

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As business co-owner and manager, I was responsible for all financial aspects of a Maine lobster fishing business, including employee payroll and benefits, accounts payable, and financial planning. I attended and testified at NOAA and Maine Department of Marine Fisheries hearings, conferences, and seminars relevant to lobster management and science, and disseminated policy information to members of the fishing community. I worked on board the fishing vessel from 1995–1998.

EDUCATION

Ph.D. in Marine Affairs 2005
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Thesis Title: "Management Thresholds in the Maine Green Sea Urchin Fishery"

Bachelor of Arts, Honors, in Environmental Public Policy 1993
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AWARDS

Secretary of Commerce, Gold Medal September 2017
Gold Medal for revising the Endangered Species Act status of the Humpback Whale with unprecedented scientific, legal, and policy creativity and intellect. This award, the highest form of honorary recognition the Department of Commerce bestows, is granted for Personal and Professional Excellence.

NOAA Fisheries Employee of the Year: Leadership/Management 2016

Secretary of Commerce, Silver Medal January 2015
Silver Medal Award for developing an effective, economical program to ensure compliance with vessel speed restrictions to protect endangered North Atlantic right whales.

NOAA Office of General Counsel Award 2015
The Georgia Aquarium Team is recognized for their outstanding work in defense of the National Marine Fisheries Service's final decision on the Georgian Aquarium's request for an MMPA permit to import beluga whales that were caught from the wild in Russia.

PAPERS, PRESENTATIONS, AND PUBLICATIONS

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MARINE MAMMAL SCIENCE, 14(1):1–37 (January 1998)

CALCULATING LIMITS TO THE ALLOWABLE HUMAN-CAUSED MORTALITY OF CETACEANS AND PINNIPEDS

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ABSTRACT

A simulation method was developed for identifying populations with levels of human-caused mortality that could lead to depletion, taking into account the uncertainty of available information. A mortality limit (termed the Potential Biological Removal, *PBR*, under the U.S. Marine Mammal Protection Act) was calculated as the product of a minimum population estimate (N_{MIN}), one-half of the maximum net productivity rate (R_{MAX}), and a recovery factor (F_R). Mortality limits were evaluated based on whether at least 95% of the simulated populations met two criteria: (1) that populations starting at the maximum net productivity level (*MNPL*) stayed there or above after 20 yr, and (2) that populations starting at 30% of carrying-capacity (*K*) recovered to at least *MNPL* after 100 yr. Simulations of populations that experienced mortality equal to the *PBR* indicated that using approximately the 20th percentile (the lower 60% log-normal confidence limit) of the abundance estimate for N_{MIN} met the criteria for both cetaceans (assuming R_{MAX} = 0.04) and pinnipeds (assuming R_{MAX} = 0.12). Additional simulations that included plausible levels of bias in the available information indicated that using a value of 0.5 for F_R would meet both criteria during these "bias trials." It is concluded that any marine mammal population with an estimate of human-caused mortality that is greater than its *PBR* has a level of mortality that could lead to the depletion of the population. The simulation methods were also used to show how mortality limits could be calculated to meet conservation goals other than the U.S. goal of maintaining populations above *MNPL*.

Key words: bycatch, cetacean, conservation, incidental fisheries mortality, management, mortality limit, *PBR*, population modeling, pinniped, U.S. MMPA.

Human activities sometimes cause the mortality of marine mammals. This mortality ranges from the obvious, such as intentional takes by commercial or subsistence harvesters, to the not-so-obvious, such as incidental mortality in fishing operations. Correctly assessing the significance of incidental mortality to marine mammal populations can be difficult. In cases where the incidental fisheries mortality is perceived to be high, such as for the well-known 1960s case of eastern tropical Pacific dolphins killed in the tuna purse seine fishery (Perrin 1969, Wade 1995), it can seem obvious that the mortality should be reduced. However, when human-caused mortality is more moderate, it becomes less obvious whether that mortality should be of concern from the standpoint of preventing the depletion of a population. Of course, some may argue that no mortality should be tolerated, but even some of the least-harmful fisheries still have the potential to cause the death of a marine mammal. Other human activities that are apparently innocuous can also cause incidental mortality, such as ships colliding with large whales (*e.g.,* Kraus 1990), yet it would be impractical to stop all ship traffic. Most people would probably agree that an activity could be considered acceptable if it only rarely caused the incidental mortality of a marine mammal (*e.g.,* one animal in 20 yr). The difficulty is how to decide when a level of mortality is no longer acceptable. This paper describes a method for setting a limit in mortality for identifying marine mammal populations with levels of human-caused mortality that may be too high.

Before a management scheme can be designed, the management goal must be defined. The management goal of the U.S. Marine Mammal Protection Act (MMPA) is to prevent populations from "depletion." The U.S. National Marine Fisheries Service (NMFS) considers a population depleted if it falls below its maximum net productivity level (*MNPL*) (Fig. 1). For marine mammals, this level is thought to be between 50% and 85% of carrying capacity and is more likely to be in the lower portion of that range (Taylor and DeMaster 1993). Therefore, populations are considered depleted by the U.S. Government if they are directly estimated to be below their *MNPL,* or if they are estimated to be below 50%–70% of a historic population size which is thought to represent carrying capacity (Gerrodette and DeMaster 1990). Although maintaining populations above *MNPL* is an excellent management goal, basing management decisions entirely on assessing status relative to *MNPL* has proven inadequate. Assessment methods such as *dynamic response* (Goodman 1988) or *back calculation* (Smith 1983) require a quantity of data unavailable for most species and cannot always be applied (Gerrodette and DeMaster 1990).

Alternatively, management actions could be triggered by criteria using trends in abundance. In fact, a series of abundance surveys were planned to monitor spotted dolphins (*Stenella attenuata*) in the eastern tropical Pacific (Holt *et al.* 1987). The goal was to detect a 10% annual decline over five years (six surveys) with 90% assurance, assuming a coefficient of variation (CV) of 12% for each annual abundance estimate. In reality, the estimated CV averaged 30% over the five surveys actually performed (Wade and Gerrodette 1992). Given that level of precision, it would take nine years (10 surveys) to detect a 10% annual decline, assuming a survey was done every year (Gerrodette 1987). Thus, the time required to estimate the trend implies that a management scheme based on detecting a significant decline in abundance would not initiate any management action until a previously unexploited population became depleted; a population declining at 10% per year would be at only 39%

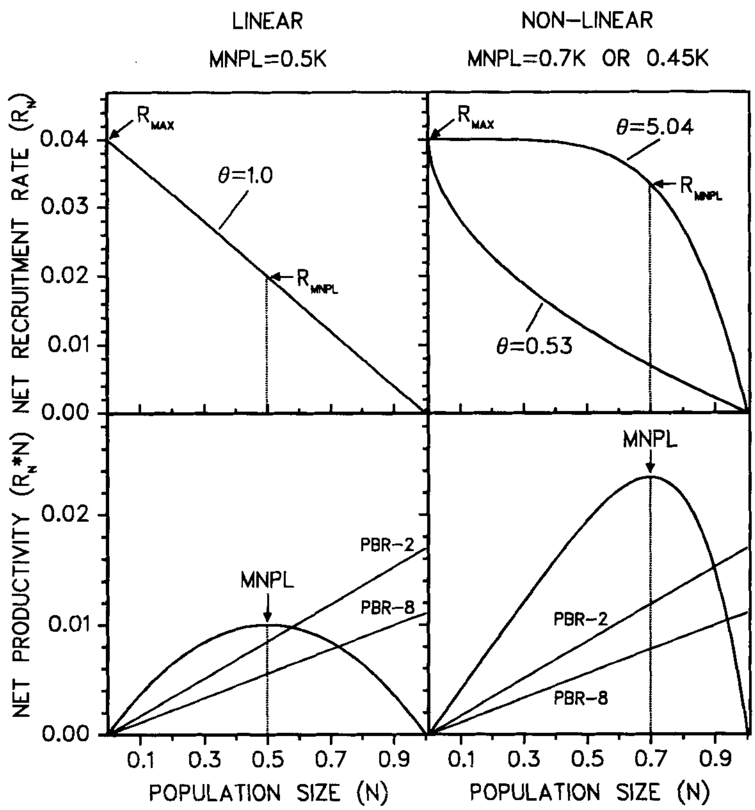

Figure 1. Illustration of density-dependent response specified by generalized logistic model (Equation 2), showing relationship between quantities discussed in text. Two panels on the left show linear model (θ = 1.0). Top panel shows linear decline of net recruitment rate (*per capita* population growth rate) with population size (expressed as fraction of carrying capacity [*K*]). Bottom panel shows net productivity curve, which is product of net recruitment rate and population size. For linear model, net productivity curve is symmetric, with maximum (*MNPL*) at 0.5*K*. Net recruitment rate at *MNPL* (R_{MNPL}) is ½ the maximum rate (R_{MAX}). Two straight lines in bottom panel represent expected *PBR* (Equation 1) calculated as product of 20th percentile of abundance estimate, ½ R_{MAX}, and value of 1.0 for recovery factor (F_R), assuming CV of abundance estimate of 0.2 (*PBR*-2) or 0.8 (*PBR*-8). Top panel on right shows two types of possible non-linear density-dependent responses of net recruitment rate. Higher curve represents example of convex density dependence (θ = 5.04), where net recruitment rate declines slowly at low population size but declines more rapidly at higher population size. Bottom panel on right shows net productivity curve associated with this value of θ, which is not symmetric and has maximum at 0.7*K*. If θ > 1.0, then *MNPL* > 0.5*K*, and R_{MNPL} > ½ R_{MAX}. Lower curve in top panel represents example of concave density-dependent response (θ = 0.53), where net recruitment rate declines more rapidly at lower population sizes than at higher population sizes. Associated net productivity curve not shown in lower panel, but *MNPL* is 0.45*K* for this value of θ. If θ < 1.0, then *MNPL* < 0.5*K*, and R_{MNPL} < ½ R_{MAX}.

of its initial population size after nine years. This problem becomes even more acute for small populations because the precision of abundance estimates decreases as abundance decreases (Taylor and Gerrodette 1993), and thus conceivably a small declining population could become extinct before it could be found to be significantly declining.

Thus, management which is dependent on detecting a trend in abundance is unlikely to maintain above *MNPL* all populations which have high levels of human-caused mortality. Gathering trend data for management would also require frequent surveys, which would be costly for the 153 defined stocks of marine mammals in U.S. waters, most of which have been subject to some form of human-caused mortality (Barlow *et al.* 1995*b*). If a decline in abundance is detected, this should, of course, initiate management response, but it may often be appropriate to take action well before it is possible to prove that a decline in abundance is occurring.

A better management scheme would use data that can be dependably gathered to initiate management actions before populations become depleted. Fortuitously, it is easier to detect the circumstances that will lead to a decline in abundance than it is to detect the actual decline itself. We can often estimate the level of human-caused mortality of marine mammals when the source of the mortality is known. Therefore, a management scheme can be based on calculating a mortality limit. Mortality above the limit would trigger management actions beyond basic monitoring.

It is obvious that such a limit has to be unique and scaled to each population and therefore must be based on mortality relative to population size, not on an absolute level of mortality. For example, it is unlikely that the kill of a single common dolphin (*Delphinus delphis*) off the coast of California would have any significance to a population recently estimated at 225,821 (Barlow 1995). However, the kill of a single individual may be of importance to a very small population such as that of the western North Atlantic right whale (*Eubalaena glacialis*), currently estimated to number only about 295 animals (Knowlton *et al.* 1994).

If we had perfect knowledge of a population's human-caused mortality, abundance (N) and dynamics, including its growth rate at the maximum net productivity level (R_{MNPL}) (Fig. 1), we could exactly determine a mortality limit that would prevent depletion to below the *MNPL*, as the product of N and R_{MNPL}. Instead, we usually have only estimates of abundance and mortality and a plausible range of growth rates based on life-history information (*e.g.*, Reilly and Barlow 1986). We also have empirical estimates of rate of increase for a few populations, such as recovering populations of pinnipeds (*e.g.*, Cooper and Stewart 1983) or baleen whales (*e.g.*, Best 1993). To ensure a robust management strategy, a mortality limit that is calculated from such information should explicitly account for the precision and bias of the available estimates of abundance and mortality, as well as for the uncertainty of the population growth rate.

Several years ago, NMFS scientists with experience in the management of marine mammals recognized the deficiencies of previous management schemes, as discussed above, and proposed a management strategy based on calculating a mortality limit (Proposed regime to govern interactions between marine mammals and commercial fishing operations, National Marine Fisheries Service Legislative Proposal, November 1992, available from the Office of Protected Resources, National Marine Fisheries Service, Silver Spring, MD). This proposal was the initial basis for what became the 1994 amendments to the MMPA, which introduced the concept of a mortality limit, termed the "potential biological removal level" or *PBR*. The proposal and the subsequent amendments attempted to implement several principles that have been developed to promote better conservation of wild, living resources, particularly that assessment should precede the use of resources and that managers should recognize the possible consequences of uncertainty and act accordingly (Mangel *et al.* 1996). Therefore, the *PBR* management scheme implemented by the 1994 amendments, and the methods I present here for calculating *PBR*s, may have value beyond the narrow focus of management of marine mammals in U.S. waters. For convenience, however, I use the (admittedly idiosyncratic) terminology of the MMPA.

The relevant specific rules, as modified by the 1994 amendments, are stated as follows in the Definitions (Section 3) of the MMPA:

> "(19) The term 'strategic stock' means a marine mammal stock—(A) for which the level of direct human-caused mortality exceeds the potential biological removal level; . . . ."
>
> "(20) The term 'potential biological removal level' means the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. The potential biological removal level is the product of the following factors:
>
> (A) The minimum population estimate of the stock.
>
> (B) One-half the maximum theoretical or estimated net productivity rate of the stock at a small population size [see Fig. 1].
>
> (C) A recovery factor of between 0.1 and 1.0."
>
> "(26) The term 'net productivity rate' means the annual *per capita* rate of increase in a stock resulting from additions due to reproduction, less losses due to mortality."
>
> "(27) The term 'minimum population estimate' means an estimate of the number of animals in a stock that—(A) is based on the best available scientific information on abundance, incorporating the precision and variability associated with such information; and (B) provides reasonable assurance that the stock size is equal to or greater than the estimate."

Therefore, from the definitions it follows that the *PBR* is calculated as:

$$PBR = N_{\mathrm{MIN}} \frac{1}{2} R_{\mathrm{MAX}} F_R \qquad (1)$$

where:

N_{MIN} = the minimum population estimate of the stock,

$\frac{1}{2}R_{MAX}$ = one-half the maximum theoretical or estimated net productivity rate of the stock at a small population size,

F_R = a recovery factor between 0.1 and 1.

Note that the goal of the *PBR* is to allow each stock to reach or maintain its "optimum sustainable population" (*OSP*):

> "(9) The term 'optimum sustainable population' means, with respect to any population stock, the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element."

To make that definition more specific, NMFS has defined *OSP* as a population level between carrying capacity and the population size at maximum net productivity (Federal Register, 21 December 1976, 41 FR 55536). Therefore, the specific goal of the *PBR* is to allow each stock to reach or maintain a population level above the maximum net productivity level (*MNPL*). This has long been the goal of the MMPA; the key difference instituted by the 1994 amendments is that management actions related to direct human-caused mortality no longer rely on detecting depletion, but on simply detecting a mortality level that will lead to depletion.

Although the MMPA specifies the three components of the *PBR*, it does not define them in quantitative terms. The purpose of this paper is to propose specific quantitative definitions for N_{MIN}, R_{MAX}, and F_R that can be used to calculate a mortality limit which can be used to evaluate the impact of known levels of human-caused mortality of marine mammals.

With perfect knowledge, a mortality limit of the product of N and R_{MNPL} would exactly maintain populations at *MNPL*. Thus, conceptually the *PBR* specifies the use of N_{MIN} to account for imprecision in the abundance estimate. Additionally, $\frac{1}{2}R_{MAX}$ is a conservative surrogate for R_{MNPL}, because $\frac{1}{2}R_{MAX}$ will always be less than or equal to R_{MNPL} if *MNPL* is greater than or equal to 50% of K (carrying capacity) (Fig. 1). Finally, F_R can be seen as both an additional factor to hasten the recovery of depleted populations and as a "safety" factor to account for additional uncertainties other than the precision of the abundance estimate. In statistical terms, using N_{MIN} addresses uncertainty due to imprecision which can be estimated. F_R, on the other hand, can be used to address potential biases caused by our ignorance of some important factors, such as stock boundaries.

Taylor (1993) used population simulations to compare the results of using two alternative definitions of N_{MIN}. She estimated PBR using mean abundance for N_{MIN} and using a lower, 2-tailed 95% confidence limit for N_{MIN}. Using the mean estimate of abundance for N_{MIN} (along with F_R = 1.0) resulted in many of the simulated populations being depleted (below *MNPL*) after 100 yr. In contrast, using the 95% lower confidence limit resulted in all populations being far above *MNPL* under the same conditions. Taylor (1993) also followed the structure used by the International Whaling Commission to test its Revised Management Plan (Donovan 1989) by performing "robustness" trials. In these trials, the performance of calculating the *PBR* in various ways was evaluated under simulations involving plausible flaws in the data or assumptions, such as substantial biases in the abundance or mortality estimates. In these robustness trials, a *PBR* calculated using the 95% lower confidence limit for N_{MIN} and an F_R of 0.5 also resulted in all simulated populations being far above *MNPL* after 100 yr.

It is worth considering whether other ways of estimating N_{MIN} are sufficient to maintain populations above *MNPL,* and whether other values of F_R are sufficient to account for potential bias or other problems with the data. The lower 95% confidence limit represents the 2.5th percentile of the sampling distribution of the abundance estimate, whereas the point estimate represents the 50th percentile. If the 2.5th percentile more than achieves the desired goal, but the 50th percentile does not, clearly some intermediate percentile could be found that would be just sufficient to result in a high probability that populations would be above *MNPL.* Similarly, various values of F_R could be tested to solve for a value that was just sufficient to account for "worst-case" scenarios of problems with the data or other information.

The intent of the proposed management scheme is to provide an appropriately conservative level for the *PBR* that will allow populations to recover to or remain above *MNPL* in spite of uncertainty, whether in the form of imprecise or biased information. R_{MAX} is unknown for most marine mammals, and only a moderate number of populations have available observed rates of increase. Gaining knowledge about the true value of R_{MAX} for any population of marine mammal is probably harder than estimating its abundance or human-caused mortality. I present a strategy that is based on assuming plausible default values for R_{MAX} for pinnipeds and for cetaceans (I will not consider what are appropriate values of R_{MAX} for other marine mammals). If population or species-specific information indicates that a value different from the default is appropriate, this specific value can and should be substituted for the default value. Thus, I proceed assuming a reasonable estimate for R_{MAX} is available (although significant bias in R_{MAX} will be addressed in the bias trials) and propose a scheme for estimating a mortality limit by ensuring that the product of N_{MIN} and F_R is less than the point estimate of abundance by a sufficient amount to achieve the management goal. The selection of an appropriate default R_{MAX} for cetaceans and for pinnipeds is discussed in the Appendix.

It is also worth considering how to set mortality limits for management objectives other than the specific U.S. MMPA goal of maintaining populations above *MNPL.* For example, one might be interested in a management goal of maintaining populations close to their pre-exploitation population level (*i.e., K*). Another type of management goal might be to allow populations to grow at a rate close to what their population growth rate would be in the complete absence of human-caused mortality. This type of criterion might be useful for calculating a mortality limit that would promote the recovery of a population that is known to have declined to a very low fraction of its pre-exploitation size, such as 5%–20% of *K.* Therefore, I will briefly illustrate a method for calculating mortality limits to achieve these other management goals, again using Equation 1. However, for clarity, the product of such calculations will be referred to as a mortality limit (*ML*) rather than as a *PBR*, because the term *PBR* refers to a specific mortality limit intended to meet the objectives of the U.S. MMPA.

METHODS

Conservation Goals and Performance Criteria

Here I describe three specific conservation goals along with criteria designed to evaluate (by simulation) whether a mortality limit will achieve the desired goal. The first goal is that of the U.S. MMPA. I propose the second and third as other possible conservation goals.

MNPL goal—maintain populations above their maximum net productivity level (*MNPL*). This is the primary management goal of the U.S. MMPA. *PBR* is calculated using values of the two parameters N_{MIN} and F_R set according to these criteria:

(1) Base case criteria—find a value for N_{MIN} (as a percentile of a point estimate of abundance) such that (a) any population in the base case of an absence of significant biases in the data will be above *MNPL* with 95% probability after 100 yr (to measure long-term performance), under mortality equal to a *PBR* calculated with an F_R equal to 1.0, and (b) a population starting at *MNPL* will still be at or above *MNPL* in 20 yr (to measure short-term performance) with 95% probability.
(2) Bias criteria—find a value for F_R such that the above criteria (1(a) and 1(b)) are also met during bias trials in which the data are assumed to have plausible unknown problems, such as significant bias.

Carrying-capacity goal—allow a population to recover to a level close to its carrying capacity, or pre-exploitation population level.

Carrying-capacity criterion—find the value of F_R such that a population which then experiences that level of human-caused mortality will equilibrate above a specified fraction of its carrying capacity, with 95% probability. To distinguish this from a *PBR* calculated to meet the *MNPL* goal of the U.S. MMPA, a mortality limit calculated with this value of F_R will be called ML_K (mortality limit to achieve a population level close to K, the carrying-capacity).

Recovery-rate goal—allow a population known to be at a low level relative to its pre-exploitation level recover at a rate close to its maximum possible.

Recovery-rate criterion—find the value of F_R such that a population starting at just 5% of its pre-exploitation level will not be delayed by more than a specified percent in the time it takes to recover to its maximum net productivity level when it experiences that level of human-caused mortality (relative to the recovery-rate of a population with no human-caused mortality), with 95% probability. A mortality limit calculated with this value of F_R will be called ML_{Rec} (mortality limit to promote recovery).

Simulation Methods

Methods nearly identical to those of Taylor (1993) were used for the simulations. The underlying population dynamics model was a discrete form of the generalized logistic equation,

$$N_{t+1} = N_t + N_t R_{MAX}\left[1 - \left(\frac{N_t}{K}\right)^{\theta}\right] \quad (2)$$

where:

N_t = population size at time t,

R_{MAX} = the maximum net recruitment rate,

K = the pre-exploitation population size or carrying capacity,

θ = the shape parameter, which controls the amount of non-linearity in the density-dependent response of the net recruitment rate and thus sets the *MNPL* (see Fig. 1).

The procedure and sequence of each simulation were:

(1) The population was projected from year t to year $t + 1$ using Equation 2, with R_{MAX} equal to either 0.04 (typical of cetaceans) or 0.12 (typical of pinnipeds). In each simulation, $K = 10{,}000$, and $\theta = 1.0$, for a *MNPL* of 0.5*K*, or 5,000.
(2) Every *i*th year (starting in year 1), an estimate of abundance was "surveyed" by randomly drawing from a log-normal distribution with a specified coefficient of variation CV(*N*).
(3) A *PBR* (or mortality limit) was then calculated from Equation 1, using the most recent survey.
(4) Incidental fisheries mortality was simulated by subtracting from the current population a Gaussian random deviate from a distribution with a mean equal to the *PBR* (or *ML*) and a coefficient of variation, CV(*M*), of 0.30.
(5) This sequence was repeated until the population was projected from year 0 to year 20, 100, or 200, depending upon the simulation. Each trajectory was initiated in year 0 at a population size equal to a specified fraction of *K*. The first survey occurred in year 1.
(6) For each trial, 2,000 trajectories were simulated, and the distribution of ending population sizes was stored. The mean and the 5th and 95th percentiles of this distribution were calculated. Thus, for example, if the lower percentile (representing the lower bound of a two-tailed 90% confidence limit) value was above *MNPL*, it could be concluded that more than 95% of the trajectories were above *MNPL*.

The sampling error of the survey was assumed to follow a log-normal distribution with a mean equal to the true population size, with a specified CV of either 0.2 or 0.8. Each abundance estimate, or "survey," was therefore generated by

Table 1. Specifications for the maximum population growth rate (R_{MAX}) and the coefficient of variation for each survey-based abundance estimate (CV(N)) for the four base case trials in the simulations.

Base cases	R_{MAX}	CV(N)
A. Cetacean, low CV	0.04	0.2
B. Cetacean, high CV	0.04	0.8
C. Pinniped, low CV	0.12	0.2
D. Pinniped, high CV	0.12	0.8

$$\hat{N}_t = \exp\left[\ln\left(\frac{N_t}{\sqrt{(1 + CV^2)}}\right) + x\sqrt{\ln(1 + CV^2)}\right] \quad (3)$$

where

x = a Gaussian random deviate with a mean of zero and a variance of 1.

N_{MIN} was calculated as the lower percentile of a log-normal distribution as

$$N_{MIN} = \frac{\hat{N}}{\exp(z\sqrt{\ln(1 + CV(N)^2)})} \quad (4)$$

where

z = a standard normal variate and thus equals 1.96 for the 2.5th percentile, 1.645 for the 5th, 1.282 for the 10th, 0.842 for the 20th, and so on.

MNPL Goal

Base case trials—A total of four "base cases" were considered (Table 1). To represent cetacean life history, two cases used an R_{MAX} of 0.04 for the *PBR* calculation (Eq. 1). One case used a CV(N) of 0.2 and the second used a value of 0.8. To represent pinniped life history, another two base cases used an R_{MAX} of 0.12 for the *PBR* calculation with the same combinations of CV(N). In all four base cases the "true" R_{MAX} in the population model (Eq. 2) was the same as the R_{MAX} used to calculate *PBR.*

Bias trials—A total of eight "bias trials" and the base case (trial 0) were considered (Table 2). Trials 1, 2, and 3 represented bias in the estimates of mortality, abundance, and R_{MAX}, respectively. Trials 4 and 5 represented situations where the variance of an estimate is severely underestimated. Trial 6 explored the result of surveying every eight years rather than every four years. Trial 7 had the true *MNPL* set to 0.45K rather than the assumed 0.5K. Trial 8 repeated trial 1 (bias in the estimate of mortality) but also had the true *MNPL* set to 0.7K rather than the assumed 0.5K. The magnitude of the assumed biases are given in Table 2. They were generally set to a level that was considered a plausible "worst-case scenario." However, deciding what level of unknown bias is plausible is an uncertain task. Some guidance can be gained

Table 2. Specifications for the bias trials for the simulation.

Trial	Description
0	Base case.
1	Estimated mortality equal to one-half the actual mortality.
2	Estimated N twice actual N.
3	Estimated R_{MAX} twice actual R_{MAX}. If estimated to be 0.04, actual R_{MAX} is set to 0.02. For estimated R_{MAX} of 0.12, actual R_{MAX} is set to 0.06.
4	Estimated abundance CV < actual CV (estimated CV of 0.2 actually 0.8, estimated CV of 0.8 actually 1.6).
5	Estimated mortality CV = one-quarter actual CV. CV(M) is set to 1.20 rather than 0.30.
6	Abundance estimated every 8 yr rather than every 4 yr.
7	True *MNPL* equal to $0.45K$ ($\theta = 0.53$) rather than assumed $0.50K$ ($\theta = 1.0$).
8	Mortality bias as in trial 1 with true *MNPL* equal to $0.70K$ ($\theta = 5.04$) rather than assumed $0.50K$ ($\theta = 1.0$).

from populations that have been studied more thoroughly than others. Justification for the plausibility of the specified magnitudes of bias is considered in the Appendix.

Carrying-Capacity Goal

The same four "base cases" were considered as above. The final population level after 200 yr (to allow time to equilibrate) was stored for simulated populations which started at $0.05K$ and experienced human-caused mortality at a level equal to ML_K, calculated with N_{MIN} equal to the 20th percentile for a range of values for F_R. It should be noted that the equilibrium level will be independent of the starting population level as long as the populations are projected for enough years, which was the case here.

Recovery-Rate Goal

The same four "base cases" were considered as above. First, a population was projected with no human-caused mortality from an initial population size of $0.05K$ to calculate how many years it took the population to reach $0.5K$. Then simulations which experienced human-caused mortality equal to ML_{Rec}, calculated with N_{MIN} equal to the 20th percentile and for a range of values for F_R, were performed, and again the year in which the population reached $0.5K$ was stored. For each simulation, the percent increase in time to recover to $0.5K$ was calculated.

Results

MNPL Goal

Base case trials—Using the best estimate of abundance (the 50th percentile) for N_{MIN} resulted in the majority of the trajectories ending up below 50% of

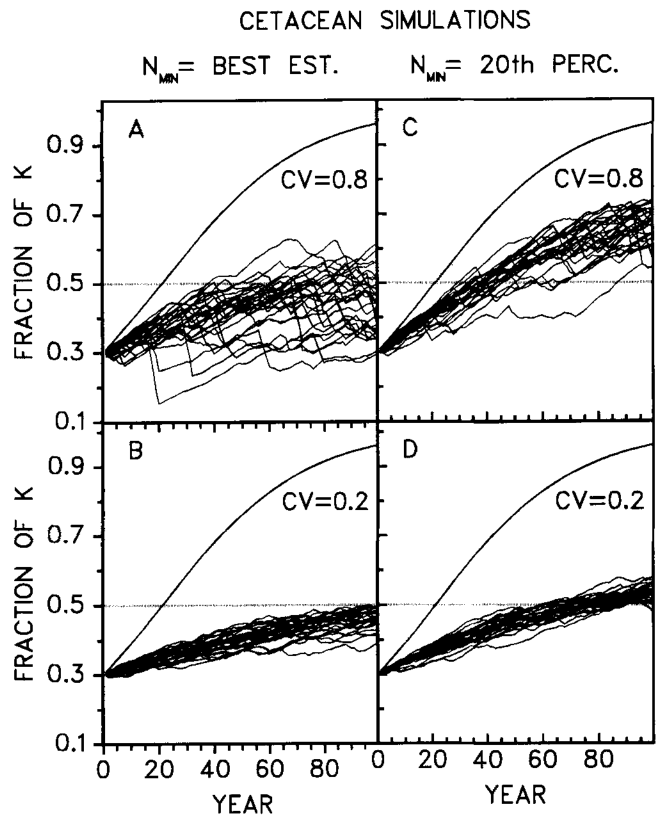

Figure 2. Simulated cetacean population trajectories (R_{MAX} = 0.04) with mean human-caused mortality equal to estimated *PBR*, showing 30 sample trajectories out of total of 2,000. Horizontal line represents maximum net productivity level (0.5*K*). Medium curved line represents a population trajectory with no human-caused mortality. The four panels differ in whether best estimate of abundance or 20th percentile of the abundance estimate was used for N_{MIN} and in whether abundance estimate has coefficient of variation (CV) of 0.2 or 0.8. (A) Using best estimate for N_{MIN} when CV = 0.8. (B) Using best estimate for N_{MIN} when CV = 0.2. (C) Using 20th percentile for N_{MIN} when CV = 0.8. (D) Using 20th percentile for N_{MIN} when CV = 0.2.

K, the *MNPL* (Fig. 2A, B; Fig. 3A, B). This replicated the results of Taylor (1993). In fact, in the pinniped simulations with poor precision of the abundance estimates (CV = 0.8), more than 5% of the trajectories went extinct (Fig. 3A; Fig. 4D). Using the 2.5th percentile (equivalent to the lower bound of a 2-tailed 95% confidence limit) for N_{MIN} resulted in all trajectories ending above *MNPL* for each case (Fig. 4), again replicating the results of Taylor (1993).

The percentile that just achieved the 100-yr performance criterion (95% of the trajectories above *MNPL* after starting at 0.3 of *K*) was close to the 20th percentile in all four base cases (Fig. 2C, D; Fig 3C, D; Fig. 4). A slightly

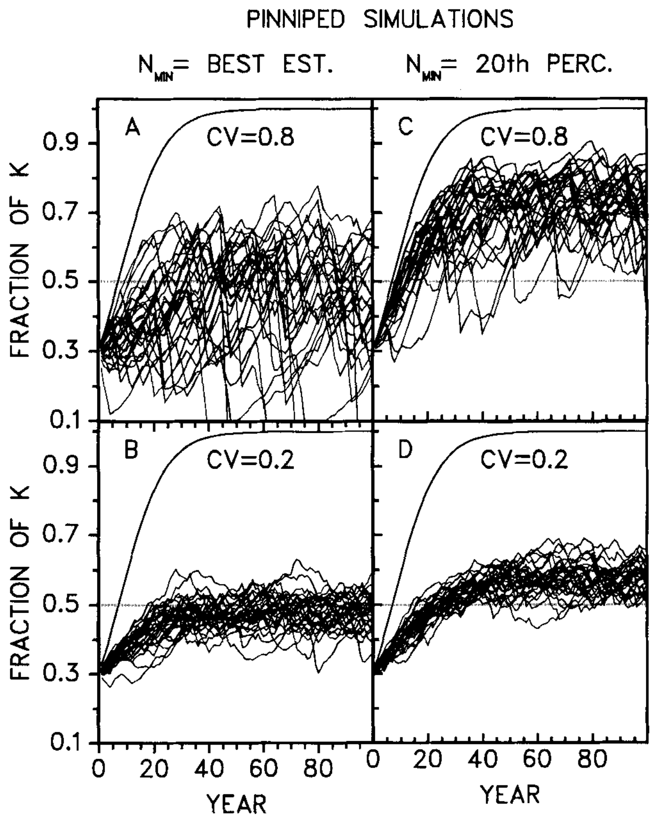

Figure 3. Simulated pinniped population trajectories (R_{MAX} = 0.12) with mean human-caused mortality equal to the estimated *PBR*, showing 30 sample trajectories out of a total of 2,000. Horizontal line represents maximum net productivity level (0.5*K*). Medium curved line represents population trajectory with no human-caused mortality. The four panels differ in whether best estimate of abundance or 20th percentile of abundance estimate was used for N_{MIN}, and in whether abundance estimate has coefficient of variation (CV) of 0.2 or 0.8. (A) Using best estimate for N_{MIN} when CV = 0.8. (B) Using best estimate for N_{MIN} when CV = 0.2. (C) Using 20th percentile for N_{MIN} when CV = 0.8. (D) Using 20th percentile for N_{MIN} when CV = 0.2.

higher value, the 25th percentile, was sufficient only for cetaceans with a high CV. Similar results were found for the 20-yr performance criterion (95% of the trajectories above *MNPL* 20 yr after starting at *MNPL*); the 20th percentile was sufficient or nearly sufficient in each case (Fig. 5). Therefore, using the 20th percentile for N_{MIN} achieved or nearly achieved both the 100- and 20-yr performance criteria.

Bias trials—After setting N_{MIN} equal to the 20th percentile of the abundance estimate, bias trial 1 (true mortality twice the estimated mortality) was run for a range of values of F_R. This type and magnitude of bias was considered a reasonable worst-case scenario, given the available information (Appendix).

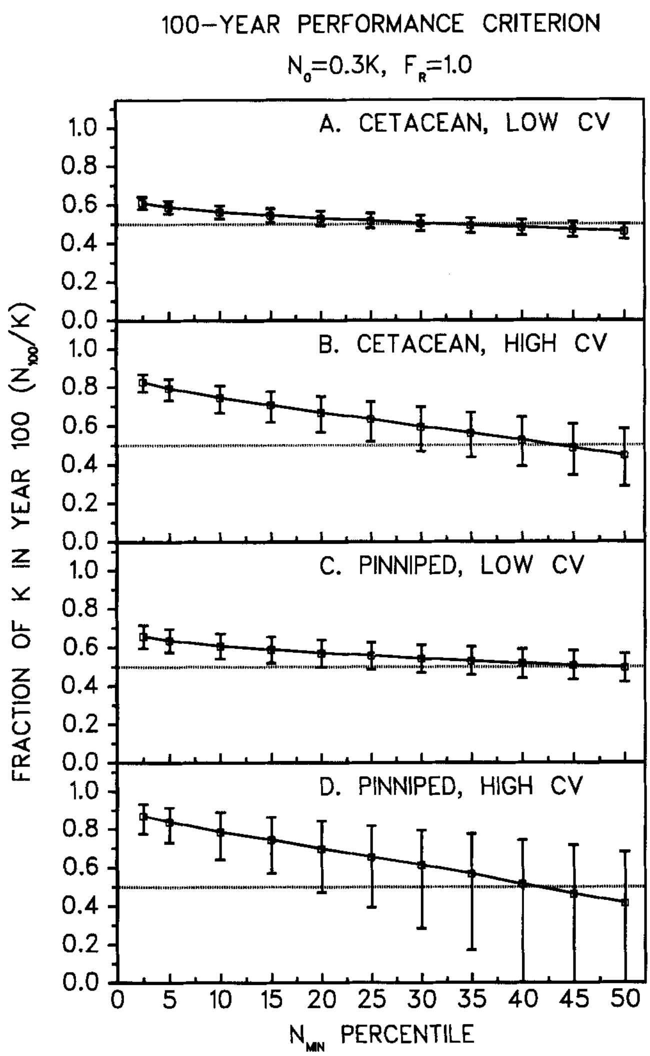

Figure 4. MNPL goal (100-yr performance criterion): population size after 100 yr *versus* percentile of abundance estimate used to calculate N_{MIN}, with F_R = 1.0 and initial population size equal to 0.3*K*. Boxes represent median value of simulations. Confidence limits capture 90% of simulations. Dotted line represents *MNPL* (0.5*K*). If lower confidence limit is above *MNPL,* simulation meets 100-yr performance criterion of 95% of trajectories ending above *MNPL.* (A) Cetacean (R_{MAX} = 0.04) with low CV (0.2). (B) Cetacean (R_{MAX} = 0.04) with high CV (0.8). (C) Pinniped (R_{MAX} = 0.12) with low CV (0.2). (D) Pinniped (R_{MAX} = 0.04) with high CV (0.8).

A value of 0.50 for F_R was sufficient or nearly sufficient for both pinnipeds and cetaceans to meet the 100-yr criterion, with 95% of the simulated trajectories above *MNPL* (Fig. 6). This is a consequence of the change in *PBR* being equivalent to the change in the mortality estimate due to the bias.

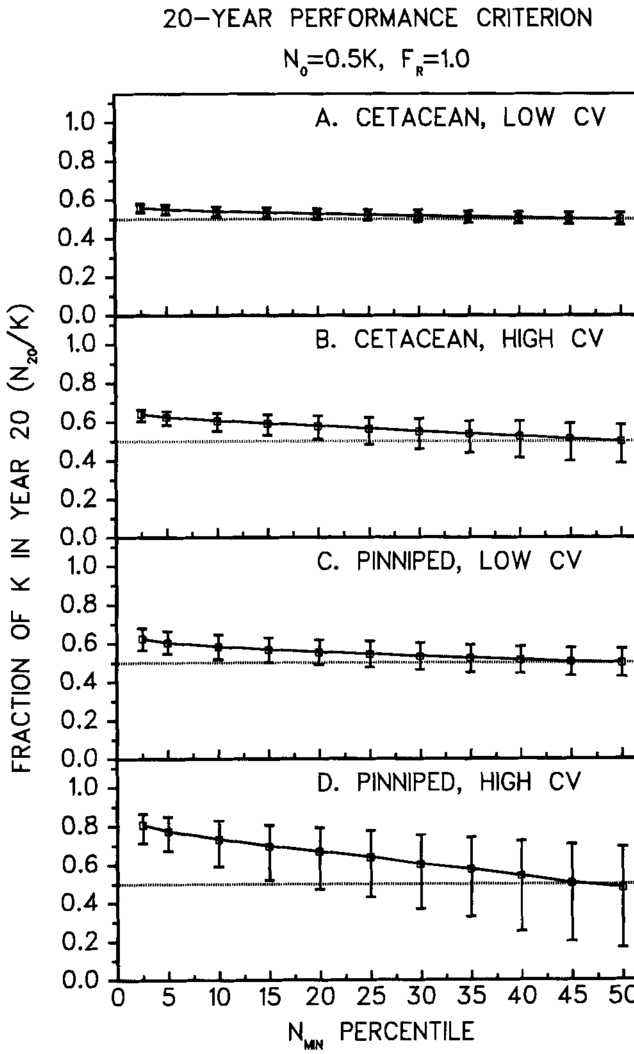

Figure 5. *MNPL* goal (20-yr performance criterion): population size after 20 yr versus percentile of abundance estimate used to calculate N_{MIN}, with F_R = 1.0 and initial population size equal to 0.5*K*. Boxes represent median value of simulations. confidence limits capture 90% of simulations. Dotted line represents *MNPL* (0.5*K*). If lower confidence limit above *MNPL*, simulation meets 20-yr performance criterion of 95% of trajectories ending above *MNPL*. (A) Cetacean (R_{MAX} = 0.04) with low CV (0.2). (B) Cetacean (R_{MAX} = 0.04) with high CV (0.8). (C) Pinniped (R_{MAX} = 0.12) with low CV (0.2). (D) Pinniped (R_{MAX} = 0.04) with high CV (0.8).

Setting F_R equal to 0.5 compensated for accidentally halving the mortality estimate and yielded the correct comparison between *PBR* and mortality.

The full bias trials confirmed that the combination of the 20th percentile for N_{MIN} and an F_R of 0.50 would meet or nearly meet the 100-yr criterion in all cases and trials (Fig. 7). Not surprisingly, bias trials 2 and 3 (overesti-

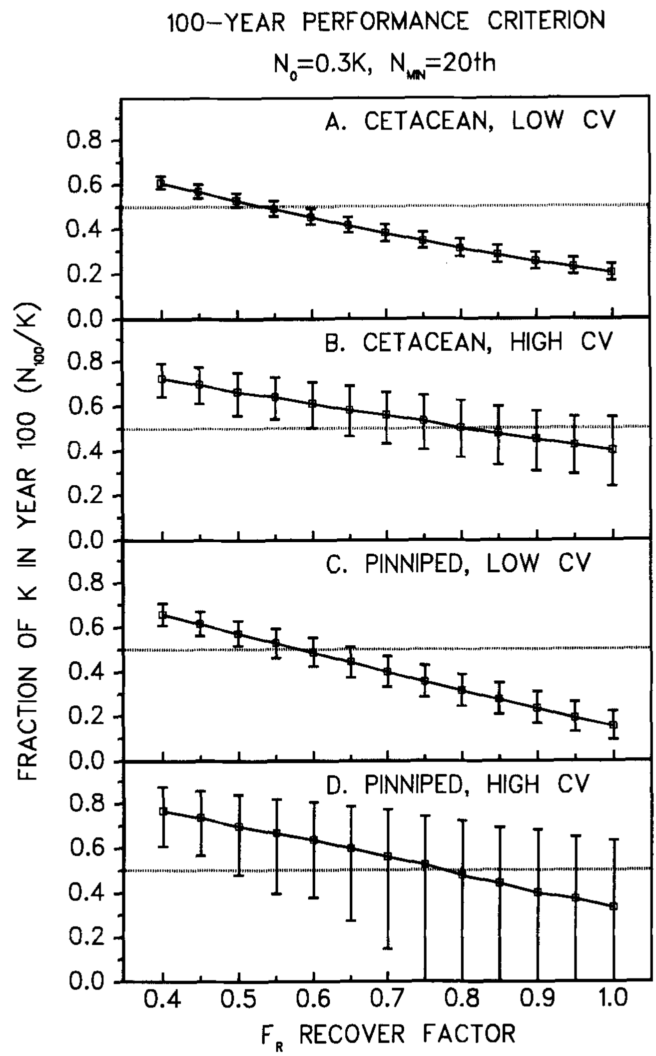

Figure 6. *MNPL* goal: bias trial 1 (true mortality twice estimated mortality), showing population size after 100 yr *versus* recovery factor (F_R) used to calculate *PBR,* with initial population size = 0.3*K.* Boxes represent median value of simulations. Confidence limits capture 90% of simulations. Dotted line represents *MNPL* (0.5*K*). If lower confidence limit is above *MNPL,* simulation meets 100-yr performance criterion of 95% of the trajectories ending above *MNPL.* (A) Cetacean (R_{MAX} = 0.04) with low CV (0.2). (B) Cetacean (R_{MAX} = 0.04) with high CV (0.8). (C) Pinniped (R_{MAX} = 0.12) with low CV (0.2). (D) Pinniped (R_{MAX} = 0.04) with high CV (0.8).

mating population size or R_{MAX} by a factor of 2) had similar results. Trials 2 and 3 both involved direct elements of the *PBR* equation and thus doubled the size of the *PBR,* whereas trial 1 effectively halved the mortality estimate. Bias trials 1, 2, and 3 had the greatest effect in terms of reducing the final population level after 100 yr relative to bias trial 0 (no bias).

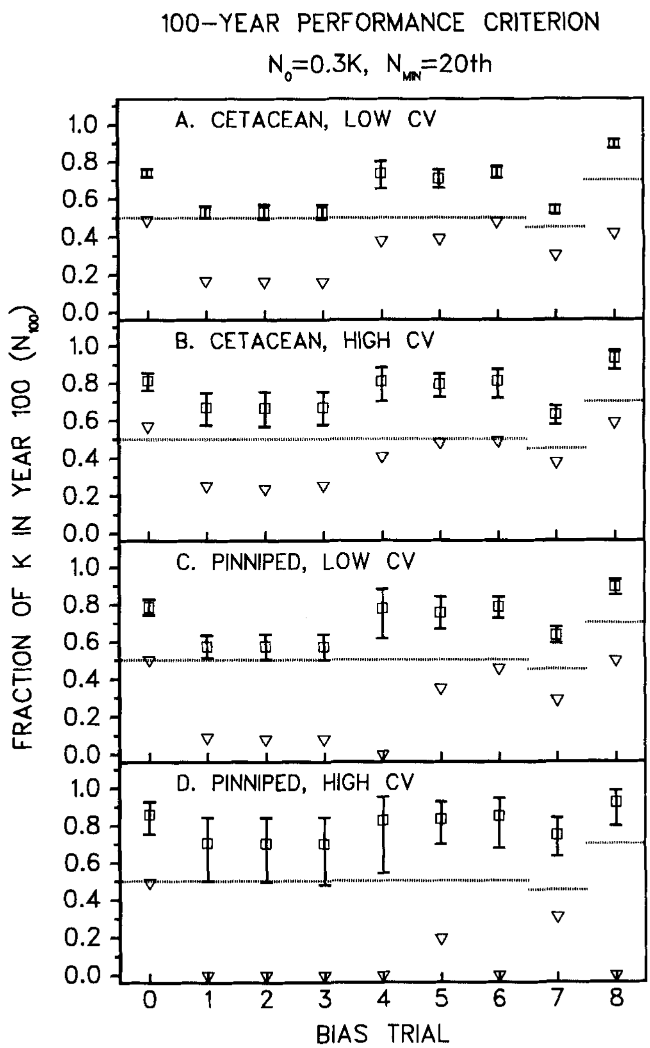

Figure 7. *MNPL* goal: population size after 100 yr for all bias trials, using 20th percentile for N_{MIN} and 0.5 for F_R, with initial population size = 0.3*K*. Boxes represent median value of simulations. Confidence limits capture 90% of simulations. Dotted line represents *MNPL*. If lower confidence limit is above *MNPL*, simulation meets 100-yr performance criterion of 95% of trajectories ending above *MNPL*. Triangles are lower confidence limits from simulations using F_R = 1.0 and thus represent effect of not accounting for unknown bias. (A) Cetacean (R_{MAX} = 0.04) with low CV (0.2). (B) Cetacean (R_{MAX} = 0.04) with high CV (0.8). (C) Pinniped (R_{MAX} = 0.12) with low CV (0.2). (D) Pinniped (R_{MAX} = 0.04) with high CV (0.8). Bias trials are (0) base case (no bias), (1) mortality, (2) abundance, (3) R_{MAX}, (4) abundance CV, (5) mortality CV, (6) survey frequency, (7) true *MNPL* = 0.45*K*, (8) mortality bias with true *MNPL* = 0.70*K*.

Severely underestimating the CV of the abundance estimate (trial 4) did not have as much effect in reducing the final population size except for the pinniped high-CV case. A value of 0.5 for F_R was sufficient to prevent depletion in that case and was more than sufficient in all the other cases. When the variance of the mortality estimates was severely underestimated (trial 5), there was less of an effect on the final population size, and an F_R of 0.5 was more than sufficient to prevent depletion. Doing abundance surveys every eight years instead of every four years (trial 6) had a strong effect only on the final population size of the pinniped, high-CV case, and again the value of 0.5 was sufficient to prevent depletion.

The effect on the final population size of an *MNPL* lower than the assumed 0.5*K* (trial 7) was moderately strong and was enough to cause depletion in each case (note that depletion here is defined as being below the different *MNPL* of 0.45*K*). A value of 0.5 for F_R was more than sufficient to prevent depletion in most cases, but only by a small margin in the cetacean low-CV case. As expected, when the true *MNPL* was 0.7*K* (trial 8) in combination with biased mortality estimates, the population did relatively better than when the true *MNPL* was 0.5*K* (trial 1), although the effect of the bias in mortality was still enough to cause the populations to be depleted. Using F_R equal to 0.5 was then more than sufficient to prevent depletion.

In all cases the results from the bias trials for the 20-yr performance criterion were very similar to the results for the 100-yr criterion and thus are not shown. A recovery factor of 0.5 was just sufficient to meet the 20-yr performance criterion for trials 1–3 and more than sufficient for the other trials.

Carrying-Capacity Goal

The resulting distributions of population levels after 200 yr are shown for various values of F_R (Fig. 8). To achieve a goal of allowing a population to recover to at least a specific fraction of *K*, the lower confidence limit has to be above that level. For example, a limit of ML_K calculated with a value for F_R of 0.15 would be required for 95% of the simulations to be above 0.9*K* in all four cases. Alternatively a limit of ML_K calculated with a value for F_R of about 0.1 would be required for 95% of the simulations to be above 0.95*K* in all four cases.

Recovery-Rate Goal

The resulting distributions of percent increases in recovery time to *MNPL* are also shown for various values of F_R (Fig. 9). To achieve a goal of not delaying the time to recovery with 95% probability, the upper confidence limit has to be less than or equal to the specified percent increase in recovery time. For example, to not delay the time to recovery by more than 10%, the upper confidence limit has to be below the line shown in Fig. 9. Therefore, a limit of ML_{Rec} calculated with a value for F_R of 0.15 should accomplish

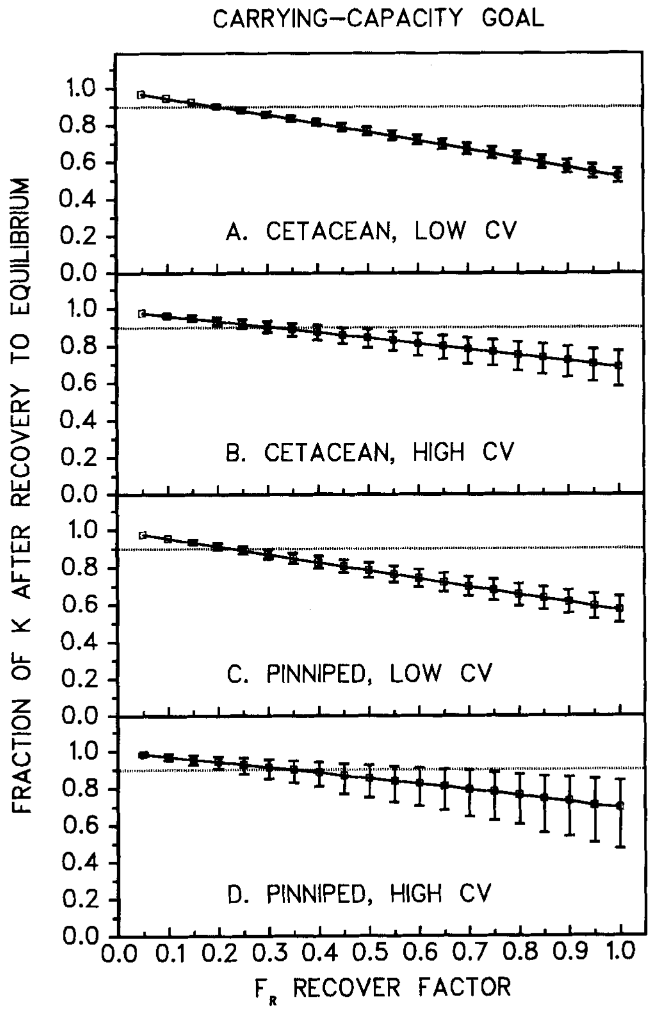

Figure 8. Carrying-capacity goal: population size after 200 yr *versus* value of recovery factor (F_R) used to calculate mortality limit ML_K, using 20th percentile for N_{MIN}. Initial population size = 0.05K but does not influence results as 200 yr is sufficient time for population trajectories to reach equilibrium. Boxes represent median value of simulations. Confidence limits capture 90% of the simulations. Dotted line represents example of possible conservation goal of maintaining populations at greater than specified fraction of K. If lower confidence limit is above line, 95% of trajectories would be at level greater than 0.9K. (A) Cetacean (R_{MAX} = 0.04) with low CV (0.2). (B) Cetacean (R_{MAX} = 0.04) with high CV (0.8). (C) Pinniped (R_{MAX} = 0.12) with low CV (0.2). (D) Pinniped (R_{MAX} = 0.04) with high CV (0.8).

this goal in all cases. Alternatively, a limit of ML_{Rec} calculated with a value for F_R of 0.25 would accomplish a goal of not delaying recovery by more than 20% for a cetacean population with a low CV (Fig. 9A), whereas a higher value of F_R would be sufficient in the other cases (Fig. 9B, C, D).

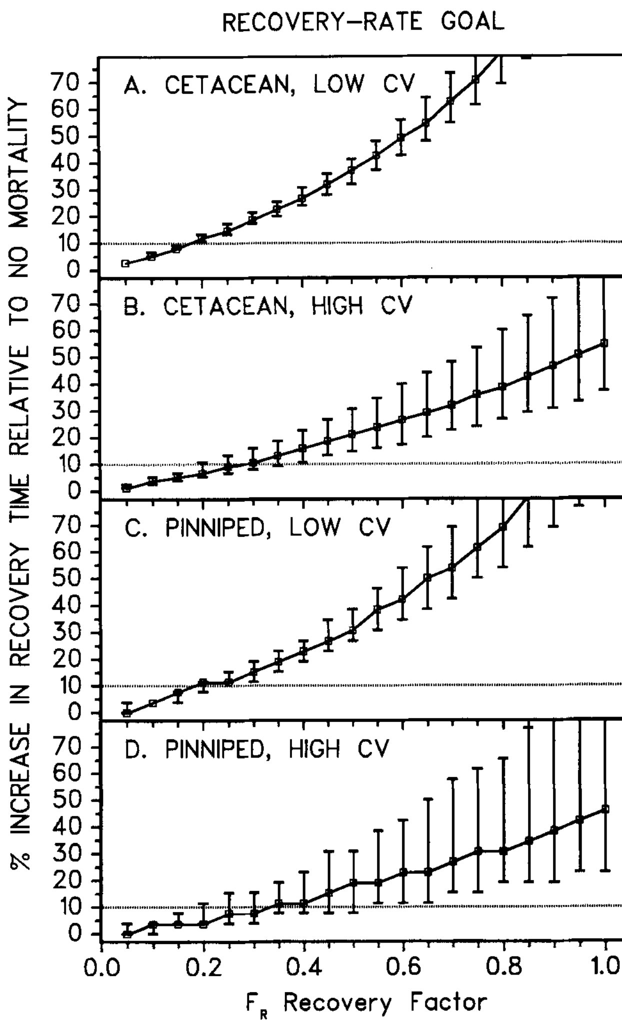

Figure 9. Recovery-rate goal: percent increase in time to recovery relative to population with no human-caused mortality, *versus* various values for recovery factor (F_R) used to calculate the mortality limit ML_{Rec}. Recovery is defined as achieving *MNPL,* although recovery to any specified population level will be delayed by approximately same percentage. Boxes represent median value of simulations. Confidence limits capture 90% of simulations. Dotted line represents 10% increase in recovery time. If upper confidence limit below 10% line, simulation meets example recovery-rate goal of 95% of trajectories not being delayed in their time to recovery by more than 10%. (A) Cetacean (R_{MAX}= 0.04) with low CV (0.2). (B) Cetacean (R_{MAX} = 0.04) with high CV (0.8). (C) Pinniped (R_{MAX} = 0.12) with low CV (0.2). (D) Pinniped (R_{MAX} = 0.04) with high CV (0.8).

Discussion

MNPL Goal

Base-case trials—A sample of 30 of the simulation trajectories gives a visual representation of the performance of the chosen value of the 20th percentile for N_{MIN} (Fig. 2, 3; panels C and D). The desired properties of the management scheme are evident; depleted populations steadily recovered to a population level above *MNPL* and stayed there, in spite of uncertainty in the estimates of abundance and mortality. Additionally, motivation exists to improve the precision of the estimates of abundance, because for a given population level the *PBR* will be higher when the CV of the abundance estimate is lower (*e.g.,* in Fig. 1, lower panels, the expected *PBR* with a CV = 0.2 would be higher than the expected *PBR* with CV = 0.8). The *PBR* successfully allowed depleted populations to recover to above *MNPL* over 100 yr (the 100-yr criterion, Fig. 4) and also successfully maintained populations above *MNPL* over 20 yr (the 20-yr criterion, Fig. 5).

Although model simulations were used here to select specific values, one good characteristic of the *PBR*-based management approach is that all three components of the *PBR* have intuitive meaning by themselves and in how they are put together to calculate *PBR.* In other words, they have meaning apart from the specific population dynamics model used in the simulations. The *PBR* can be thought of as an appropriately conservative estimate of what the current net production of the population would be if it were currently at a true *MNPL* of 0.5*K.*

One half of R_{MAX} should be a conservative estimate of the current net production rate of a depleted population (*i.e.,* a depleted population should achieve more than $\frac{1}{2}R_{MAX}$ if there are no Allee effects), thus reserving part of the net production of the population for recovery. It will not be a conservative estimate if the population is not depleted. The 20th percentile of the abundance estimate represents a population level that should be smaller than the true population size and is based on the familiar concept of a lower confidence limit of the abundance estimate. Thus, current production is calculated from appropriately conservative values of the current production rate and the current population size. Using a recovery factor of less than 1.0, such as 0.5, provides a safety factor to account for levels of unknown bias or estimation problems that have been observed in some populations of marine mammals and would also account for less severe biases co-occurring, such as overestimating R_{MAX} while underestimating mortality.

It would be possible to perform simulations tailored to the specific information available for a particular stock. In other words, a *PBR* for each stock could be calculated from a unique simulation determined by the stock's specific estimates of abundance, mortality, and their associated CVs. However, a panel of scientists convened to review this issue recommended a simpler approach (Barlow *et al.* 1995*b*). That is, there is utility in having the *PBR* calculated from familiar quantities (such as a predetermined confidence limit) so that the process of calculating a mortality limit can be more transparent and intuitive to the casual observer rather than being a quantity that just emerges from a complex computer simulation.

Setting N_{MIN} equal to the 20th percentile of an abundance estimate maintained about 95% of the simulated populations above *MNPL* for all four base cases. It would be possible to calculate for each specific base case an exact percentile (that would be close to but different from the 20th percentile) that would meet the 100-yr performance criterion exactly for that particular base case. However, it is likely that a different percentile would result from meeting the 20-yr performance criterion exactly, and then it would be uncertain which percentile should be used. Additionally, as reasonable as the base-case simulations are, no one can be confident that they exactly represent the true dynamics of any real marine mammal population. Therefore, there is no strong reason to calculate an exact percentile for each case. Thus, the 20th percentile serves as a generic standard that can be expected to work reasonably well in a variety of real world situations.

Some examples illustrate the use of the *PBR*. Harbor porpoises (*Phocoena phocoena*) are killed incidentally in gillnet fisheries throughout their range. The Gulf of Maine population of harbor porpoises is impacted by the sink gillnet fishery. Abundance surveys in 1991 and 1992 led to a combined estimate of 47,200 (CV = 0.19) (Palka 1995). The 20th percentile of the abundance estimate is 40,297. Using the default R_{MAX} of 0.04 and a value of 0.5 for F_R means that the *PBR* is equal to $0.01N_{MIN}$, and is thus 403. Total fisheries mortality in 1993 was estimated to be 1,876, which is more than four times the *PBR* (Blaylock *et al.* 1995). In this case, the *PBR* calculation identified a population for which the mortality may not be sustainable.

Similarly, harbor porpoises in central California have been killed in the set gillnet fishery for Pacific halibut for many years, which may have caused the population to decline (Forney 1995). The most recent abundance estimate for this stock is 4,120 (CV = 0.31) from surveys from 1988 to 1993 (Barlow and Forney 1994), which results in an N_{MIN} of 3,431 and a *PBR* of 34. Fisheries mortality was greater than 100 per year for every year from 1979 to 1987, with a peak of 303 in 1984 (Barlow and Forney 1994). Fisheries mortality has decreased since the peak but was still equal to or greater than the *PBR* in every recent year through 1992. A substantial drop in fishing effort led to an estimated mortality in 1993 of only 11 animals. Thus, for this stock, human-caused mortality was greater than the *PBR* and may have caused a decline in the population, but the 1993 level of mortality was probably sustainable.

As a final example, harbor seals (*Phoca vitulina richardsi*) in Oregon and Washington coastal waters have been incidentally killed in several gillnet fisheries. In 1991–1992, the estimated mortality in the Washington and Oregon lower Columbia River drift gillnet fishery for salmon was an average of 213 harbor seals a year, with total mortality (including two other fisheries) estimated at 233 per year. The abundance of this population in 1992 was estimated to be 29,939 (CV = 0.062), which results in an N_{MIN} of 28,322 (Barlow *et al.* 1995*a*). A *PBR* calculated as the product of N_{MIN}, 0.06 (½ of the R_{MAX} of 0.12), and 0.5 (F_R) would be 849. The estimated human-caused mortality is well below this hypothetical conservative *PBR*[1], and therefore it can be concluded that this level of mortality is sustainable. Corroborating this conclusion is the evidence that this population is currently increasing in size (Barlow *et al.* 1995*a*).

Bias trials—The bias trials involve levels of bias that should be relevant to a variety of marine mammal populations, as most of the specified magnitudes of bias have been noted at least one time in real situations (Appendix). Past experiences with potential biases in estimates of mortality, abundance, and R_{MAX} (trials 1–3), as well as the definition of stock structure, lend justification to the concept of using a safety factor to guard against unknown biases when potential problems cannot be ruled out. Trials 4 and 5 indicate that biases in the estimated variances of mortality and abundance are less worrisome. In situations where it is known there is no bias in the parameters, and where the stock structure is accurately identified, a *PBR* calculated with an F_R of 1.0 should be a sufficient limit for human-caused mortality. However, the question remains as to when one will be sufficiently confident that no bias exists and that the stock structure is correctly identified. Only the most well-studied marine mammal populations will meet such high standards. Therefore, the default case should be to use a value of F_R less than 1.0, such as the value of 0.5 that was shown here to pass the specified bias trials. This will ensure a robust management procedure that will work for populations of unknown status, even under conditions of fairly severe bias in the collection of data. Populations meeting specified criteria regarding available information could have F_R increased from the default value. This potential would encourage the collection of better information when the effect of a certain level of human-caused mortality on a population is in question. One possible criterion for increasing F_R could be if a population increases while experiencing a known level of incidental mortality, which provides confirmation that such a level of mortality is sustainable. However, before such action is taken to raise the F_R value from the default value, reasonable assurance in the form of scientific justification should be provided to ensure that the estimates of abundance, mortality, and R_{MAX} are not severely biased and that the coefficients of variation of the abundance and mortality estimates are within the range used in these simulations (< 0.8 for the abundance estimate, < 0.30 for the mortality estimates).

The simulations were run assuming *MNPL* was 0.5*K*. If *MNPL* is actually higher than 0.5*K*, populations will achieve higher population levels than they would have with *MNPL* equal to 0.5*K*. For example, in bias trial 8, which is identical to trial 1 except for having an *MNPL* of 0.7*K* rather than 0.5*K*, the simulated trajectories reach both a greater population level and a greater level relative to *MNPL* (Fig. 7). This occurs because the *PBR* is calculated assuming a growth rate of $\frac{1}{2}R_{MAX}$ at 0.5*K*, but populations with an *MNPL* greater than

[1] Note that the actual *PBR* for this stock was 1,699; $F_R = 1.0$ was used because the population is significantly increasing (Barlow *et al.* 1995*a*).

$0.5K$ will actually be growing at a rate higher than $\frac{1}{2}R_{MAX}$ when they are at $0.5K$ (Fig. 1). The inability to precisely estimate *MNPL* for any marine mammal population, even some of the best studied (Ragen 1995), is part of the motivation for moving to a management scheme that does not require knowing what the *MNPL* actually is. The proposed management scheme is robust to higher values of *MNPL*. In such cases a population with human-caused mortality as great as the *PBR* would exceed the performance criteria specified here (*i.e.*, the *PBR* would be conservative relative to the goal of having 95% of the trials meet the short-term and 100-yr performance goals).

Bias trial 8 indicated by how much the population might exceed the performance criterion. Under the condition of true mortality twice the estimated mortality, with F_R equal to 1.0, it can be seen that populations with *MNPL* equal to $0.7K$ would still become depleted. The additional benefit to the population of the higher *MNPL* level was not enough to compensate for the biased mortality estimates. When F_R is set to 0.5, all of the simulated populations recover (as expected) to higher population levels than those of trial 1, where *MNPL* was equal to $0.5K$ (Fig. 7). Such populations exceed the performance criterion by a moderate to large amount, whereas when the true *MNPL* was $0.5K$, the populations just met the performance criterion (trial 1). This amount of potential extra conservatism seems a reasonable trade-off, *versus* the possibility of depletion given the complete lack of information regarding specific *MNPL* levels.

Note that in each bias trial only one parameter was assumed biased (except trial 8). In real situations, consideration needs to be given to the possibility of multiple biases.

The Carrying-Capacity and Recovery-Rate Goals

The goals of the U.S. MMPA are reasonable but, of course, are not the only goals which could be considered for managing the human-caused mortality of marine mammals. For example, one possible conservation goal could be to maintain populations at or near their pre-exploitation level (*i.e.*, their population level in the absence of human-caused mortality). Under the U.S. MMPA, a population previously unexploited would be allowed to decline to a level just above *MNPL*, which could be a level as low as 50% of *K*. However, such a decline would be unacceptable if one had the goal of maintaining populations close to their pre-exploitation levels. Conservation goals are rarely stated in specific quantitative terms. However, if a specific goal can be stated, such as maintaining populations at a level above 90% of *K*, then a limit of ML_K can be set by choosing the appropriate value for F_R from Figure 8.

The second type of alternative goal considers the population growth rate rather than the final population level; this might be most appropriate for managing the human-caused mortality of populations that are at a small fraction of their pre-exploitation level. Ensuring that the time to recovery is not substantially delayed is a way of ensuring that the population growth rate is not substantially reduced, thus promoting recovery. Like the use of the *PBR*, setting a mortality limit in this way allows a management scheme to work without requiring one to be able to estimate precisely the exact level of the population relative to its pre-exploitation size, as the limit ML_{Rec} is based on an abundance estimate and is calculated in the same way regardless of the current population level. In other words, this scheme can be applied to populations which are thought to be at a low level even if it is impossible to know precisely where they are relative to K.

The mortality limit ML_{Rec} may be useful for species given special protection status because they are at a low level. For example, in the U.S., most large whales were listed as "Endangered" under the U.S. Endangered Species Act because they were thought to have been reduced to low population levels by commercial whaling. Therefore, the U.S. in calculating *PBR*s chose to use a value of 0.1 for F_R for these species, based partly on the rationale that this would not cause more than a 10% increase in the time to recovery (Barlow *et al.* 1995*b*). Such a mortality limit should allow a large fraction of the net production of the population to go to population increase and eventual recovery and should thus have a relatively insignificant negative impact upon the population.

However, managing the human-caused mortality of endangered species involves some special considerations. A mortality level that is not thought to have much of an impact on the population growth rate would appear to be insignificant. However, for populations of extremely low abundance, any human-caused mortality may be significant. For such populations, the effect of human-caused mortality needs to be evaluated in the context of how much it might increase the risk of extinction for the population, which is beyond the scope of this paper. In other words, the goal of not delaying recovery time does not substitute for a proper population viability analysis (Gilpin and Soule 1986) that considers other factors, such as environmental and demographic stochasticity, that is most appropriate for evaluating the human-caused mortality of a small population that is at risk of extinction.

Additionally, situations where a population is declining for unknown reasons makes the evaluation of known human-caused mortality difficult. A mortality limit may still be useful in evaluating the role of various known sources of human-caused mortality. For example, if a declining population has an incidental fisheries mortality that is less than the *PBR*, one can then fairly reliably conclude that the fisheries mortality is not solely responsible for the decline. This allows managers to set research priorities; in this case they would need to investigate other possible causes of the decline besides the fisheries mortality.

Model Assumptions

The generalized logistic model used in these simulations is admittedly one that oversimplifies nature. However, it should accurately represent the main features of marine mammal population dynamics that are important to setting limits for human-caused mortality, with certain caveats discussed below.

The base trials assumed that *MNPL* was at least 0.5*K*. Eberhardt (1977) suggested that *MNPL* might be well above 0.5*K* for marine mammals, which corresponds to a convex non-linear response of the net recruitment rate to population size (*e.g.*, Fig. 1 with *MNPL* = 0.7*K*). Fowler (1981) used a model based on an evolutionary argument to infer that cetaceans would have an *MNPL* level well above 0.5*K*. Empirical evidence that is available for large, long-lived mammals has shown convex non-linear density dependence in life history parameters such as age-specific birth and mortality rates (Fowler *et al.* 1980; Fowler 1987, 1994), which would again indicate *MNPL* > 0.5*K*. Similarly, the data sets available for marine mammals, though fewer in number (Fowler 1984), are generally consistent with those found for large terrestrial mammals. Goodman (1980) showed that a linear density-dependent change in only the birth rate (which implies *MNPL* = 0.5*K*) would actually cause the population growth curve to be convex (*MNPL* > 0.5*K*). Taylor and DeMaster (1993) reviewed the available empirical data and concluded that (1) marine mammals show density-dependent responses, (2) these responses are not abrupt changes close to *K* (*i.e.*, knife-edge), and (3) these responses have not been shown to be concave, though the statistical power to detect concavity is low. Their analyses showed that combinations of even highly convex density-dependence in more than one life history parameter translates into a population level response where the inflection point of the growth curve (*i.e.*, *MNPL*) occurred at a population level that was less than 0.8*K*. Further, a concave population response could be produced only by the combination of linear responses in several life-history parameters. This, in combination with the lack of evidence for concave responses in life history parameters, led them to conclude that *MNPL* > 0.5*K* (Taylor and DeMaster 1993).

As shown and discussed above, the *PBR* scheme is robust to population dynamics which have a value for *MNPL* greater than 0.5*K*. Bias trial 7 showed that a value for F_R of 0.5 would be sufficient to make the scheme robust to values of *MNPL* as low as 0.45*K*. At some lower value for *MNPL* the scheme would no longer be robust, but there is little evidence to suggest such dynamics in large mammals. Such a low *MNPL* implies that individual animals feel the effects of the addition of another animal to the population much more strongly at very low densities than at high densities. In Figure 1 it can be seen that a value of less than 0.45*K* for *MNPL* would imply that a population can achieve a *per capita* growth rate of more than half its maximum possible value only when it is reduced to less than about 25% of its carrying capacity. Although such strongly concave dynamics in a single life-history parameter of a large mammal are not known to occur, it should be recognized that MacCall and Tatsukawa (1994) provided a theoretical mechanism for producing such dynamics from strong density-dependent habitat selection combined with certain types of habitat gradients (see the Appendix for further discussion of this point).

The generalized logistic model does not have what is referred to as the Allee effect, where at some point the net production rate declines as population size gets lower, rather than continuing to increase. Fowler and Baker (1991) concluded that the Allee effect was likely to be a common phenomenon in animal population dynamics, especially populations at a level less than $0.1K$. Therefore, the Allee effect is an important consideration for assessing the risk of extinction (Fowler and Baker 1991) but would likely not be of significance to the *MNPL* goal simulations performed here, as those simulations all start at $0.3K$ or higher. However, the Allee effect could influence the recovery time of populations reduced to lower levels and thus warrant further attention for calculations of ML_{Rec}.

The generalized logistic model also does not explicitly take into account the age and sex structures of the population. This should not make a difference in estimates of N_{MIN} or F_R as long as the human-caused mortality is relatively random with respect to age and sex. However, if the human-caused mortality is highly selective, it could be a cause for concern. Higher mortality of females relative to males would likely cause a population to decline to a lower level than if the mortality were random. Similarly, selective mortality of animals close to the age of sexual maturity would also have a greater impact, as these are the animals with the greatest reproductive value to the population. Where possible, data on the age and sex distributions of the animals killed should be collected. If such data indicate that the mortality is highly selective, a case-specific simulation could be used to calculate a *PBR* in a way similar to the approach used here, but using an age- and sex-structured model to account for selective mortality.

The model used is deterministic rather than stochastic, meaning that there is no variability in the population growth rate at a particular population size due to environmental variance. Simulations using a stochastic model would be possible, but specifying the amount of environmental variance to simulate for cetaceans may be difficult because such data are difficult to obtain. For pinnipeds, it is often possible to see environmental effects upon populations, such as large changes in the number of pups produced from one year to the next. The simulation results presented here may be relatively robust to environmental variance, as the *PBR* will be self-correcting in one sense; a sudden decline in a population due to unfavorable environmental conditions will be reflected in a lower subsequent abundance estimate and thus result in a lower *PBR*. However, it would still be useful to investigate the effects of stochastic dynamics through simulations which incorporated plausible levels of environmental variance.

Alternatives

There are other ways that N_{MIN} and F_R could be adjusted to meet the same performance criteria specified here. For example, F_R could be set to 1.0 and then the N_{MIN} percentile could be found that would have passed the bias trials. Alternatively, a point estimate of abundance could be used for N_{MIN}, and the value of F_R could be found that would have passed the bias trials. However, the two-part procedure suggested here has some desirable qualities. First, using a lower confidence limit for N_{MIN} is an intuitively reasonable method of accounting for the uncertainty of an abundance estimate. For management in the U.S., it also meets the intent of the 1994 amendments to the MMPA, which state that N_{MIN} "(A) is based on the best available scientific information on abundance, incorporating the precision and variability associated with such information; and (B) provides reasonable assurance that the stock size is equal to or greater than the estimate." Second, using a lower confidence limit encourages improving the precision of abundance estimates, as lower CVs result in higher *PBR*s. Third, separating the factors that account for precision (N_{MIN}) and other uncertainties such as bias (F_R) allows for flexibility in management. Finally, as discussed before, a *PBR* calculated this way has some biological meaning, as the product of N_{MIN} and R_{MAX} represents a conservative estimate of what the current net production would be if the population were at *MNPL,* and the recovery factor accounts for possible unknown biases and problems.

Another area that could be explored would be how to combine abundance estimates to improve precision. The simulations used here ignored previous abundance estimates once a new "survey" was performed. Use of previous estimates would involve a trade-off between improving precision by using more data and increasing potential bias from using abundance estimates made when the population was possibly at a different size. The performance of various methods of combining abundance estimates over a specified time period could easily be investigated, using the same simulation framework presented in this paper.

Conclusions

Adjusting the values of N_{MIN} and F_R to meet specific criteria should allow for a robust management procedure that will prevent the depletion of marine mammal populations by known human-caused mortality. This can be accomplished without being unnecessarily conservative or restrictive on the sources of human-caused mortality, such as commercial fisheries. If an estimate of human-caused mortality exceeds the calculated *PBR* for a population, it should serve as a warning that the mortality could lead to the depletion of the population.

It is important to note the distinction between estimating mortality to be greater than the *PBR versus* detecting a significant decline in abundance. Where mortality exceeds the *PBR,* it may be sufficient to cause a decline in abundance and subsequent depletion. This situation can be identified with only a single abundance estimate. This is not the same as directly detecting a significant decline in abundance, which generally takes many years of data (Gerrodette 1987). Initially, some populations with sustainable levels of human-caused mortality may, by chance alone, have estimated mortality greater than *PBR.* However, if the level of mortality is truly sustainable, subsequent estimates will show mortality to be less than or equal to the calculated *PBR.* The simulations performed here must be interpreted to mean that if mortality is consistently estimated to be greater than the *PBR* over many years, then the population will become depleted with a probability estimated to be > 0.05. Estimating incidental mortality in one year to be greater than the *PBR* calculated from a single abundance survey does not prove the mortality will lead to depletion; it identifies a population worthy of careful future monitoring and possibly indicates that mortality-mitigation efforts should be initiated.

ACKNOWLEDGMENTS

Credit for developing the concept of a *PBR*-based management scheme is due mostly to Jay Barlow and Doug DeMaster. Additionally, they, along with Barbara Taylor, gave me much guidance in developing the concept of the simulation study presented here. The particular strategy used here for setting N_{MIN} and F_R evolved from discussions with Jay Barlow, Barbara Taylor, and Tim Gerrodette. I must also acknowledge that the discussions held at the *PBR* Workshop, 27–29 June 1994, greatly influenced the final form of this manuscript, and I thank all the workshop participants. The manuscript was greatly improved by thorough reviews from Jay Barlow, Douglas P. DeMaster, Barbara L. Taylor, William F. Perrin, and two anonymous reviewers. The author was supported during the initial part of this work by a National Research Council Associateship funded by the Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, California.

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Received: 14 May 1996
Accepted: 29 August 1996

Appendix

Plausibility of the Specified Bias Trials

The specified types and magnitudes of bias were chosen because they were thought to represent real possibilities. Justification for the selected levels of bias is presented here. Because the bias trials represent simulations under conditions of unknown bias, there is no definitive way to objectively determine what the magnitude of an unknown bias might be. However, it is possible to examine known biases to gain some insight into what plausible unknown biases might be.

Trial 1: Mortality Estimates

There are several ways in which estimates of incidental fisheries mortality can be biased. Usually, only a small fraction of all fishing trips are observed in a fishery, and mortality rates from those observed fishing trips are extrapolated to the total effort of the fishery. This standard method will give an unbiased estimate of marine mammal mortality only if the observed trips are representative of all trips. One way in which this assumption can be violated is if there are "observer effects" in which the behavior of the fishermen is different when they carry an observer aboard than when they do not. For example, a statistical analysis concluded that significant observer effects occurred in the eastern tropical Pacific tuna purse-seine fishery (Wahlen and Smith 1985). However, this fishery probably represents a special case in that the rate of marine mammal mortality is very much dependent upon the expertise of the crew and the amounts of time and energy expended to release dolphins from the net.

A more general source of potential bias from observer effects can occur if marine mammal mortality rates vary predictably depending upon when and where the fishermen fish. For example, harbor porpoise mortality rates in the Gulf of Maine sink gillnet fishery have been seen to vary by location and time of year, which has led to the implementation of time-area closures to attempt to reduce the mortality (NMFS 1994*a*). Where such variation in mortality rates exists (without time-area closures being implemented) the potential exists for fishing vessels with observers to stay away from areas where they have experienced high incidental takes of marine mammals in the past. This could lead to overall mortality being underestimated.

Mortality estimates for gillnet or other fisheries can also be biased because animals fall out of the gear while the gear is being hauled in and thus are not counted by an observer. Net fallout which could be observed from the vessel was found to be a potential problem in observing the Gulf of Maine sink gillnet fishery, where it was determined that many incidentally caught porpoises did not come aboard the vessel, and thus it was important for the observers to watch the net as it came out of the water (NMFS 1994*b*). Of course, in any gillnet fishery the possibility also exists that caught animals may fall out of the net or swim away entangled in a portion of the net before the net is retrieved and so may never be observed. Quantifying this kind of bias would be very difficult, as it would involve inspecting the net while it is still in the water in its fishing position just prior to being hauled in.

There are other potential sources of bias in mortality estimates that are common. Often, due to logistical or practical difficulties, it is not possible to place observers on vessels in a completely representative way. For example, it may be possible to place observers only on vessels in the larger ports, so vessels fishing out of smaller ports (and their mortality rates) may be under-represented. Also, fishing effort is often estimated using surrogate measures, such as the quantity of fish landed, and such conversions introduce the possibility of other kinds of bias. In conclusion, unless observer coverage approaches 100%, in many fisheries it will be difficult to exclude the possibility of bias in mortality estimates. It is plausible that mortality could be underestimated by one-half. For example, this could occur if mortality rates differed by a factor of 2 spatially, and if observed boats always went to known low-mortality locations.

Trial 2: Abundance Estimates

This trial used a twofold positive bias in abundance. Most estimates of abundance for cetaceans are from line-transect data. Most potential biases of line-transect data are negative, and sources of positive bias are limited. One known source for some species is attraction to vessels, which is often a problem with Dall's porpoise (*Phocoenoides dalli*), for example, and can introduce more than a twofold positive bias. Such a bias would be more than is accounted for by this bias trial, but it should be recognizable and not remain unknown (and thus be corrected for).

Another possible positive bias, especially for dolphins, comes from overestimating mean group size because of the easier detection of large groups. However, such a bias is unlikely to result in a greater than twofold overestimate of abundance. This type of bias is also identifiable and correctable.

Abundance might be overestimated by a factor of two very easily from incorrectly identifying the stock structure of the population in question, such as in a situation where two stocks with limited movement between them were considered one stock. Abundance would essentially be overestimated by a factor of 2 in a case where the stocks were of equal size and all human-caused mortality was in the region of just one stock. This is a plausible unknown bias because examples exist of just such scenarios. For example, the two stocks of harbor porpoise in California waters have estimated abundances of 4,120 for the central stock and 9,250 for the northern stock, but incidental fisheries mortality in the coastal set gillnet fishery occurred only within the range of the central stock (Barlow and Forney 1994). If the two stocks were treated as one stock, the lumped abundance would essentially overestimate, by a factor of more than 3, the estimated abundance of the population experiencing the mortality.

Trial 3: R_{MAX}

The *PBR* calculations assume that R_{MAX} is 0.04 for cetaceans and 0.12 for pinnipeds. Where species-specific information is available, it should be used rather than these defaults. However, it is difficult to estimate R_{MAX} because of the difficulty in estimating all of the life history parameters for marine mammals. In particular, survival rates are difficult to estimate, as to do so requires following the fate of individual animals within an increasing population over long periods of time. Alternatively, observed rates of increase may or may not serve as a good surrogate for R_{MAX}, depending on whether or not the population is at a low level relative to carrying capacity. Observed rates of increase should at least provide a lower bound for R_{MAX}. Therefore, a brief review of what data are available for some species may provide some guidance for setting default values when no data are available for a species. If the true value of R_{MAX} is higher than the default, then the *PBR* as calculated is too conservative. The issue here for the bias trial is what the appropriate value to use as a default is when no data are available. Most important is to choose a reasonable value for R_{MAX} for most species, while minimizing the possibility that this value is much higher than the true unknown value of any particular species. Such species could become depleted if their human-caused mortality were as high as a *PBR* calculated using the default value.

There are several estimates of rates of increase greater than 4% for mysticetes, especially southern hemisphere right whales (*Eubalaena australis*) (Best 1993). However, the northwest Atlantic population of right whales, *E. glacialis,* has been estimated to be growing at only 2.5% per year (Knowlton *et al.* 1994). Because that population is estimated to number only a few hundred animals, it should be growing at a maximum rate unless some form of depensation is taking place. The estimated net productivity (increase plus harvest) of gray whales, *Eschrichtius robustus,* was about 4% per year from 1968–1988 (Reilly 1992). An estimate of 3.4% per year was made for bowhead whales, *Balaena mysticetus* (Zeh *et al.* 1991). Although some mysticete populations apparently have an R_{MAX} greater than 4%, in unknown situations 4% is a reasonable default. Given the apparent observed rate of the northwest Atlantic right whale, 2% is a reasonable worst-case scenario.

Modeling of the life history of some odontocetes indicated that R_{MAX} could be as high as 0.06 if survival rates were very high (Reilly and Barlow 1986). However, such a high rate of increase has never actually been observed in an odontocete, although few observations of any kind exist. The rate of increase for a population of resident killer whales (*Orcinus orca*) has been estimated at 2.9% (Olesiuk et al. 1990*a*) and 2.5% (Brault and Caswell 1993) per year, but the maximum rate for this population could be higher. The eastern spinner dolphin (*Stenella longirostris orientalis*) was estimated to have an R_{MAX} of only 2%, although the 95% confidence limit on that estimate did not exclude 4% as a possible value (Wade 1994). In the same study the northeastern stock of offshore spotted dolphins (*Stenella attenuata*) was estimated to have an R_{MAX} of about 4% (Wade 1994). The lack of evidence of higher rates suggests that 4% is probably a suitable default value for odontocetes and that 2% represents a reasonable worst-case scenario. However, some caution is required, as so few data exist on observed rates of increase of odontocetes. Also, although several odontocete populations have apparently declined from human-caused mortality, none have been observed to recover. Although this may be due to the difficulty in monitoring odontocete populations, it also suggests that maximum rates of increase for some odontocetes could be even lower than 2%.

Some observed rates of increase are available for recovering phocid populations. The highest estimated rate of increase for the total northern elephant seal (*Mirounga angustirostris*) population is 8.3% per year (Cooper and Stewart 1983). Harbor seals (*Phoca vitulina*) in British Columbia increased at 12.5% per year from 1974 to 1988 (Olesiuk *et al.* 1990*b*). A preliminary estimate of the rate of increase of harbor seals in California was 9.7% per year from 1982 to 1992 (Barlow *et al.* 1995*a*). The Oregon and Washington coastal-waters stock of harbor seals increased 11% per year from 1977 to 1982 (Barlow *et al.* 1995*a*). The pup production of three undisturbed populations of grey seals (*Halichoerus grypus*) in the Outer Hebrides (1970–1976), Orkney (1964–1968), and the Farne Islands (1956–1971) increased at 6%–7% per year (Summers 1978); these populations were not at extremely low population sizes and they have likely increased at least since being partly protected in 1914, so the maximum growth rate for gray seals is possibly higher. The highest observed rate of increase at a breeding site for the Hawaiian monk seal (*Monachus schauinslandi*) is only 5%–6% per year (Gilmartin and Eberhardt 1995).

Several rates of increase are available for recovering otariid populations, especially in the Southern Hemisphere. Antarctic fur seal (*Arctocephalus gazella*) pup counts on South Georgia were estimated to have increased at 16.8% per year from 1958 to 1972 (Payne 1977), but a correction factor for undercounting was applied only to the last data point. An analysis of the uncorrected counts gives an estimate of 13.1% per year (York 1987). The total population of subantarctic fur seals (*Arctocephalus tropicalis*) increased 12.9% per year from 1951 to 1988 on Marion Island and 9.7% per year from 1982 to 1988 on Prince Edward Island, and the antarctic fur seal (*Arctocephalus gazella*) increased 10.9% per year from 1981 to 1988 on Marion Island (Wilkinson and Bester 1990).

However, for the Northern Hemisphere, York (1987) pointed out the great difference observed between *Arctocephalus* spp. and the northern fur seal (*Callorhinus ursinus*), which has been well studied and whose maximum observed rate of increase in pups was only 8% per year from 1911 to 1924 (Kenyon *et al.* 1954). A preliminary estimate of the net productivity rate of California sea lions (*Zalophus californianus*) from 1980 to 1994 was 11.7% per year (Barlow *et al.* 1995*a*).

In conclusion, 12% is a reasonable default value for R_{MAX} for both phocids and otariids. The information available regarding the monk seal suggests 6% may be a plausible worst-case scenario for phocids, although it is debatable how relevant the life history of monk seals is to other phocids. Six percent is likely a conservative worst-case scenario for otariids. The relatively low observed rate for the well-studied northern fur seal (8%) indicates that although many otariids have been observed to increase at rates of around 12% per year, it is not safe to assume that any otariid will necessarily increase at a rate that high.

Trial 4: CV of the Abundance Estimate

Although there is often much discussion of potential biases in abundance estimates, there has not been as much consideration given to potential biases in estimates of the variance of those abundance estimates. However, long-time series of abundance have occasionally resulted in more interannual variation in abundance estimates than expected from the estimated variance. For example, annual estimates of abundance for the southern stock of common dolphin (*Delphinus delphis*) in the eastern tropical Pacific showed a significant decline from 1986 to 1987 and then a significant increase to 1988 (Wade and Gerrodette 1992), changes which could not be due solely to mortality and reproduction of the population. The explanation was likely a low estimate in 1987 caused by a distributional shift of the population to the south, out of the study area, creating additional interannual variability not accounted for by the CV of the estimated abundance. Another example comes from the long series of abundance estimates available for gray whales, in which adjacent abundance estimates have non-overlapping confidence limits, indicating some component of the variance has not been accounted for (Reilly 1992).

Although this kind of bias is clearly possible, there is not much guidance for defining a worst-case scenario. The specified bias trials (CV actually 0.8 when estimated to be 0.2, and CV 1.6 when estimated to be 0.8) were not based on experience with actual situations. They were somewhat arbitrarily chosen to be magnitudes of bias greater than what one might imagine was reasonable.

Trial 5: CV of the Mortality Estimate

Bias trial 5 (CV of the mortality estimated to be 0.3 but actually 1.2) was similarly chosen in an arbitrary fashion, with perhaps less information available, indicating its potential to be a problem. However, it is possible to imagine situations which would lead to bias in the estimated variance of the mortality estimates. One example would be an observer effect that resulted in vessels fishing in areas with lower variability in their bycatch rates when an observer was on the vessel.

Trial 6: Survey Frequency

Although not strictly addressing a bias, it seemed appropriate to explore the consequences of doing surveys less frequently than was assumed during the simulations.

Violation of this assumption will be known, of course, so the implications of doing surveys less frequently than every eight years can be investigated, if necessary, at a later time.

Trial 7: MNPL *Less Than 0.5*K

As noted in the Discussion, Taylor and DeMaster (1993) reviewed the available empirical data and concluded that density-dependent responses in marine mammals have not been shown to be concave, although statistical power to detect this is low. Taylor and DeMaster (1993) also noted that a linear response in several life-history parameters simultaneously could generate a population-level response that was concave and thus had a maximum net productivity level of less than 0.5*K*, but there was likewise no known example of such a population. Concave dynamics have not often been suggested for marine mammals. Such dynamics imply that adding an individual to the population at a low population size has a greater effect on the other individuals in the population than does adding an individual at a high population size. For example, in the case used here, if R_{MAX} is 0.04 and *MNPL* is 0.45K, the *per capita* growth rate has already fallen to 0.02 (half the maximum rate assumed to exist at a very low population size) by the time the population is at only 0.27*K* (Fig. 1). In other words, the potential of the population to grow has been substantially reduced at a small fraction of its carrying capacity. If *MNPL* is equal to 0.5*K*, a linear decline in *per capita* growth rate results, which implies that adding an individual to the population has an effect independent of the population size, and thus the *per capita* growth rate declines to 0.02 at 0.5*K*. A more-than-linear decline is not seen in life-history parameters (Fowler 1987), and a decline more severe than implied by an *MNPL* of 0.45*K* seems unlikely given the available life-history data.

The exception to the above conclusion is the density-dependent habitat selection hypothesis of MacCall and Tatsukawa (1994). Under this hypothesis, selection can generate a population response that is concave even if local dynamics are convex. However, the hypothesis relies on strong habitat selection by the animals and on a constant gradient in habitat quality within the environment. For example, this assumes that there exists a small piece of habitat (such as 1% of the total habitat area) that is "best," and that any animals outside this best area will have a lower population growth rate irrespective of animal density. Furthermore, in applying this mechanism it is necessary to assume that if such best habitat is available, any animal not in such habitat will find it. MacCall and Tatsukawa (1994) recognized that it is unknown whether the assumptions of their model hold true for any whale population but cautioned that such a possibility would mean that local population dynamics would not provide an accurate account of overall population behavior.

Trial 8: MNPL *More than 0.5*K *with Biased Mortality Estimates*

It is thought that *MNPL* is somewhere between 0.50 and 0.85 of *K* for marine mammals (Eberhardt 1977, Fowler 1987). Although Taylor and DeMaster (1993) recognized that some range is plausible, they suggested that *MNPL* is probably not greater than 80%. Their reasoning was based on their analyses which indicated that non-linear dynamics in a single life-history parameter translate into more linear dynamics in the population response, if the other life-history parameters have a linear response themselves. Thus, for the population-level response to have an *MNPL* of 0.85*K*, either (1) all of the life-history parameters would have to have that extreme a non-linear response simultaneously, or (2) some of the single life-history parameters would have to have an even more extreme non-linear response, close to knife-edge, for which they concluded there was little evidence. The level of $0.7K$ used in this trial is therefore towards the high end of the probable range for marine mammals, but there is admittedly still much uncertainty in this conclusion.

Incorporating Uncertainty into Management Models for Marine Mammals

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Abstract: *Good management models and good models for understanding biology differ in basic philosophy. Management models must facilitate management decisions despite large amounts of uncertainty about the managed populations. Such models must be based on parameters that can be estimated readily, must explicitly account for uncertainty, and should be simple to understand and implement. In contrast, biological models are designed to elucidate the workings of biology and should not be constrained by management concerns. We illustrate the need to incorporate uncertainty in management models by reviewing the inadequacy of using standard biological models to manage marine mammals in the United States. Past management was based on a simple model that, although it may have represented population dynamics adequately, failed as a management tool because the parameter that triggered management action was extremely difficult to estimate for the majority of populations. Uncertainty in parameter estimation resulted in few conservation actions. We describe a recently adopted management scheme that incorporates uncertainty and its resulting implementation. The approach used in this simple management scheme, which was tested by using simulation models, incorporates uncertainty and mandates monitoring abundance and human-caused mortality. Although the entire scheme may be suitable for application to some terrestrial and marine problems, two features are broadly applicable: the incorporation of uncertainty through simulations of management and the use of quantitative management criteria to translate verbal objectives into levels of acceptable risk.*

Incorporación de la Incertidumbre en Modelos de Manejo para Mamíferos Marinos

Resumen: *Los modelos buenos de manejo y los modelos buenos para el conocimiento de la biología difieren en su filosofía básica. Los modelos de manejo pueden facilitar las decisiones de manejo a pesar de la gran cantidad de incertidumbre sobre las poblaciones manejadas. Estos modelos pueden estar basados en parámetros que pueden ser fácilmente estimados, la mayoría considera explícitamente la incertidumbre y deberían ser simples de entender e implementar. En contraste, los modelos biológicos son diseñados para elucidar el funcionamiento de la biología y no son restringidos por asuntos de manejo. En este trabajo ejemplificamos la necesidad de incorporar la incertidumbre en los modelos de manejo mediante la revisión de la incompetencia en el uso de modelos biológicos convencionales en el manejo de mamíferos marinos en los Estados Unidos. En el pasado el manejo se basaba en un modelo simple que a pesar de poder representar las dinámicas poblacionales adecuadamente, fallaba como una herramienta de manejo debido a que el parámetro que desencadenaba las acciones de manejo era extremadamente difícil de estimar para la mayoría de las poblaciones. La incertidumbre en la estimación de parámetros resultó en pocas acciones de conservación. Describimos un esquema de manejo recientemente adoptado que incorpora la incertidumbre y su implementación resultante. La metodología usada en este esquema simple de manejo, el cual ha sido probado usando modelos de simulación, incorpora la incertidumbre y determina el monitoreo de la abundancia y la mortalidad causada por humanos. A pesar de que el esquema completo puede ser adecuado para aplicarse a problemas tanto terrestres como marinos, pocas características son ampliamente aplicables: la in-*

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Paper submitted September 2, 1999; revised manuscript accepted April 5, 2000.

corporación de la incertidumbre mediante simulaciones de manejo y el uso de criterios cuantitativos de manejo para traducir objetivos verbales en niveles aceptables de riesgo.

Introduction

The primary goal of a management model is to use data to make decisions that result in meeting management objectives. Management objectives are usually defined by law, regulation, or some management body such as a fisheries council or a recovery team. For example, the primary objective of the U.S. Marine Mammal Protection Act (1972) is to maintain populations above a certain level. Yet after more than 20 years of management under this act, and despite declines in the abundance of some populations, only a few populations received any conservation action. The history of management using a biological model demonstrates that ignoring uncertainty results in failure to take needed conservation actions. We contrast this history with the current management model, proscribed in the 1994 amendment to the act, which explicitly incorporates uncertainty to rectify past inadequacies. The marine mammal example shows how a rarely implemented law can be turned into a functioning and proactive law through appropriate consideration of uncertainty. Another important feature of the new management scheme is that, prior to being written into law and regulations, it was tested by simulation of the management process. Our purpose is not to provide the details of the actual model and testing procedure, which have been published elsewhere (Taylor 1993; Wade 1998), but to provide the history of the development of a management model and emphasize that the new management scheme functions well largely because of the explicit treatment of uncertainty.

Management has failed in the past not because the model driving management actions did not adequately represent population dynamics but rather because the law was interpreted to require proof that populations were in a certain state ("depleted") before actions were taken. At an international level, at least part of the blame for the spectacular overexploitation of the great whales can be placed on scientists being unable to agree on parameters used in simple models to drive management decisions: there was no clear way to treat uncertainty. For brevity, we detail the evolution of management models for marine mammals within the United States, but a similar evolution has taken place in models developed by the International Whaling Commission (Cooke 1994). We then describe the current management model and how it differs in basic philosophy from models that scientists typically use to understand biological processes.

The 1972–1993 Model for Marine Mammal Management in the United States

The Marine Mammal Protection Act (MMPA) contains two primary objectives: to maintain populations (1) above their optimum sustainable population level (OSP) and (2) as functioning elements of their ecosystem. The first objective was defined by the National Marine Fisheries Service (NMFS; Gehringer 1976) as a population with abundance exceeding the maximum net productivity level (MNPL). The MNPL was defined as the population size that would yield ". . . the greatest net annual increment in population numbers or biomass resulting from additions to the population due to reproduction and/or growth less losses due to natural mortality." In theory, management action was essentially binary: no kills of marine mammals were allowed if population abundances fell below MNPL—formally classified as "depleted" under the MMPA—and no management actions were required for populations above MNPL. The problem was in estimating both what MNPL was and where the population was in relation to MNPL.

The concept of MNPL follows from the generally agreed principle that marine mammal populations experience density-dependent population growth. For example, a commonly used simple model (Pella & Tomlinson 1969; Gilpin et al. 1976) that represents density-dependent growth is

$$N_{t+1} = N_t + R_{\mathrm{MAX}} N_t \left(1 - \left(\frac{N_t}{K}\right)^{\theta}\right), \qquad (1)$$

where N is abundance, t is time, R_{MAX} is maximum population growth rate, K is carrying capacity, and θ is the shape parameter. The MNPL is determined by K and θ. If $\theta = 1$, then equation 1 is a standard logistic equation with a linear decrease in growth between $N = 0$ and $N = K$, and MNPL $= 0.5\ K$.

Numerous theoretical papers have attempted to quantify MNPL as a proportion of carrying capacity for long-lived mammals (Goodman 1981; Fowler 1984; Fowler 1988; Gerrodette & DeMaster 1990; Taylor & DeMaster 1993). For example, Taylor and DeMaster (1993) examined combinations of density-dependent changes in age-specific birth and death rates and found it likely that MNPL is between 50% and 85% of carrying capacity.

Results of 1972–1993 Management Model

Of the 153 stocks (62 species) of marine mammals under U.S. management, assessments that in some way at-

Table 1. Marine mammal stocks for which an attempt was made by the National Marine Fisheries Service to assess status relative to the maximum net productivity level (MNPL) prior to 1994.

Stocks[a]	*Number of stocks*	*Method*[b]	*Status*[c]	*Source*
Eastern tropical Pacific dolphins (spotted, spinner, common, striped)	9	back-calculation	D(2)	Smith 1979, 1983; Wade 1993a, 1993b, 1994
Gray whale	1	back-calculation, dynamic response	no	Reilly 1981; Gerrodette & DeMaster 1990
Bowhead whale	1	back-calculation	E	Breiwick et al. 1981
North Pacific small cetaceans (Pacific white-sided dolphin, northern right whale dolphin)	2	back-calculation	no	Hobbs & Jones 1993
Harbor porpoise (California)	1	back-calculation	no	Barlow & Hanan 1995
California pinnipeds (northern elephant seal, California sea lion, harbor seal)	3	dynamic response	no	Boveng 1988a, 1988b, 1988c; Boveng et al. 1988
Steller sea lion	2	decline >50%	E, T	Merrick et al. 1987
Northern fur seal	1	decline >50%	D	York 1987
Bottlenose dolphin (Atlantic coast)	1	strandings	D	Scott et al. 1988
Total	21			

[a] *Stocks on this list had a documented analysis (source) that attempted to determine population status relative to MNPL. Not all assessments had conclusive results. Scientific names not previously mentioned in the text: spotted dolphin (*Stenella attenuata*), common dolphin (*Delphinus delphis*), striped dolphin (*Stenella coeruleoalba*), bowhead whale (*Balaena mysticetus*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), Northern elephant seal (*Mirounga angustirostris*), California sea lion (*Zalophus californianus*), harbor seal (*Phoca vitulina*), bottlenose dolphin (*Tursiops truncatus*).*

[b] *Back-calculation, calculating pre-exploitation size from estimates of recent abundance and annual estimates of human-caused mortality; dynamic response, analysis of observed dynamics (Goodman 1988); decline >50% observed trend indicating a decline in abundance of greater than 50%; strandings, analysis of an anomalous stranding event.*

[c] *Status is D for stocks designated as depleted under the Marine Mammal Protection Act (MMPA); E or T for stocks listed as endangered or threatened under the ESA (and thus automatically considered depleted under the MMPA); or no for stocks not listed under the MMPA or ESA.*

tempted to determine status relative to OSP were completed for 21 stocks over 21 years (Table 1). In U.S. waters (i.e., excluding eastern tropical Pacific dolphins), only 8% (12 of 153) of the stocks were assessed. We equate the definition of *stock* with *management unit*, which is essentially a unit—usually geographically delineated—defined to meet specified management objectives (for further discussion, see Moritz 1994; Taylor 1997). Attempts to directly estimate MNPL were made for only two species: spinner dolphins (*Stenella longirostris*; Smith 1984) and northern fur seals (*Callorhinus ursinus*; Ragen 1990). Ragen (1990) emphasized that MNPL could not be estimated reliably even for the largest available data set (northern fur seals). Reilly (1992) made the same point for California gray whales (*Eschrichtius robustus*), which are the best-known population of baleen whales. Attempts to estimate population level relative to MNPL (without actually estimating MNPL itself) were made for 17 stocks (Table 1), but few of these stock assessments were successful in unambiguously determining whether the stock was depleted. In addition, indirect methods, such as observed declines in abundance of over 50% were used to define three stocks as depleted without need for further consideration of population level relative to MNPL (Table 1). Only four stocks are currently designated depleted without also being listed under the U.S. Endangered Species Act, and only six other stocks (excluding eastern tropical Pacific dolphins) were formally assessed to see whether management actions were needed. We review two case studies to illustrate the management lessons learned during this period.

Eastern Tropical Pacific Dolphins

The case of tropical dolphins killed by tuna fishing illustrates the amount of data required before populations could be listed as depleted. In 1969 the first reports of high mortality of dolphins in the eastern tropical Pacific tuna purse-seine fishery (Perrin 1969) triggered a program to estimate total mortality (Lo & Smith 1986). Increased observer coverage in the early 1970s confirmed that mortality was high, which prompted dolphin abundance estimation surveys beginning in 1977. Several of the dolphin populations were estimated to be below MNPL (Smith 1983) based on abundance estimates (Holt & Powers 1982), mortality estimates for 1959–1979, and assumptions about likely population growth rates. Disputes, including litigation from the tuna industry, about the uncertainty of several of the inputs into those analyses led an administrative law judge to reject such depletion designations (Marine Mammal Commission 1982). Conclusive analyses sufficient to justify the depleted status of these populations (Wade 1993*a*, 1993*b*) required a tremendous amount of data: nine abundance surveys over 12 years, 17 years of relative trend indices from data collected on the tuna vessels, 25 years of observer data on dolphin mortality rates in the fishery, and 34 years of data on fishing effort. The requirement to show conclusive proof led to a listing delay of 14 years from the first abundance survey and an estimated 23-year delay from the date of depletion (Wade 1994).

International management and industry actions in the early 1990s (Joseph 1994) led to a dramatic decline in the levels of dolphin mortality. These management actions were not clearly related to designation of the stocks as depleted under the MMPA.

Harbor Porpoise in California

In the mid-1980s, increasing numbers of stranded harbor porpoise (*Phocoena phocoena*), along with an expanding coastal gillnet fishery in central California, indicated that the population of harbor porpoise in the region of the fishery may have been at some risk. A fishery observer scheme was instituted to estimate the number of animals being killed, and surveys were conducted to estimate abundance. In an attempt to determine whether the population was depleted, the abundance of porpoise in earlier years was back-calculated using data on fishing effort and kill rates (Barlow & Hanan 1995). Uncertainty in many parameters made determination of status relative to MNPL impossible. Nevertheless, approximately 10% of the population was being killed annually, and porpoise populations cannot grow fast enough to replace such large annual losses (Barlow & Boveng 1991), so it was unlikely that the fishing mortality could be sustained by the local population. A larger population exists in northern California, but the extent of mixing between the local central California population and this northern California population was and is unknown. The potential problem of excessive kills was solved for the harbor porpoise not by MMPA actions but rather by actions under the Endangered Species Act to protect sea otters (*Enhydra lutris*) being killed in the same fishery, which closed so many areas that fishing became largely unprofitable. Again, the well-intentioned but unworkable former MMPA management scheme failed to protect its intended target.

Lessons from the 1972–1993 Experience

Although some management actions were taken during the MMPA's first 20 years, few were triggered by the mathematical model that defined depletion. Actions that were taken involved highly publicized issues such as the tuna-dolphin problem, in which hundreds of thousands of animals were taken in a concentrated fishery. Management actions resulted primarily from political pressure associated with problems that could be observed readily. Most fisheries had no monitoring of marine mammal mortality, and there were no abundance estimates for the vast majority of species. For species other than the few with a long time series of both kills and abundance (northern fur seals, eastern tropical Pacific dolphins, and gray whales), estimation of current status relative to historical numbers proved an impossible task. We also learned that using trends in abundance was a risky strategy for most cetacean species for which estimates of abundance are imprecise. Taylor and Gerrodette (1993) noted in reference to the vaquita (*Phocoena sinus*), an endangered porpoise, that the species is likely to go extinct before a statistically significant trend can be determined.

We have learned that we can estimate three things fairly well: abundance, its associated precision, and mortality rates. Because many marine mammal populations are recovering from overexploitation, we also have numerous estimates of population growth rates that are probably close to the maximal rates. What was needed, then, was a management system that (1) was based on a model that used data we could gather, (2) incorporated uncertainties in the data, and (3) facilitated management decisions in a timely manner. In other words, we sought a management system that could be implemented and that could survive legal scrutiny. Further, a system was needed that could be easily explained to constituents in the environmental and fishery communities as well as to politicians and administrators who cannot be expected to be well versed in population dynamics.

The Current Model for Marine Mammal Management

Recognizing that the previous management regime was not working, in 1998 the U.S. Congress placed a moratorium on most MMPA provisions that dealt with fishery mortality and asked scientists at the NMFS and U.S. Fish and Wildlife Service to propose a new management scheme. The Marine Mammal Commission (Robert Hofman, testimony to Senate Committee on Commerce, Science and Transportation, 14 July 1993) defined the following objectives for marine mammal management: (1) maintain the fullest possible range of management options for future generations, (2) restore depleted species and populations of marine mammals to optimum sustainable level with no significant time delays, (3) reduce takes (kills) to as near zero as practicable, and (4) as possible, minimize hardships to commercial fisheries while achieving the previous objectives. These objectives are based on the precautionary principle of Holt and Talbot (1978): "Management decisions should include a safety factor to allow for the facts that knowledge is limited and institutions are imperfect," and "The magnitude of the safety factor should be proportional to the magnitude of risk."

The new management regime grew out of proposals from the NMFS, the Marine Mammal Commission, fishing groups, and environmental organizations. It sought to do three things: (1) to explicitly consider uncertainty in management, (2) to base management on parameters that could be estimated, and (3) to provide incentives to gather better data. This regime, now part of the 1994 amendments to the MMPA, requires that total annual human-caused mortality and serious injury be less than potential biological removal (PBR), as follows:

$$PBR = N_{\mathrm{MIN}} \frac{1}{2} R_{\mathrm{MAX}} F_R, \qquad (2)$$

where, N_{MIN} is minimum population estimate, R_{MAX} is maximum population growth rate, and F_R is recovery factor.

Behind the model is a simple idea: humans should not remove more than the population needs to maintain at least half of its current carrying capacity (K) (or, if K has been constant, historical numbers). To get an intuitive grasp of the PBR management scheme, consider an analogy of shooting at a target. Instead of a bullseye, the target is a square with a horizontal line bisecting the midpoint. For any given shot at the target, the goal is always (i.e., with high probability) to place your round above the line. This symbolizes maintaining populations above MNPL. Imagine that you want to make certain when you shoot that you hit above a line 95% of the time. Now consider two guns: a pilgrim's musket and a sniper's rifle. The rifle shoots with great precision and is equivalent to an abundance estimate with a very low coefficient of variation (CV). Even an expert marksman, however, would be considerably less precise with the musket: repeated attempts with the musket result in a more diffuse pattern than with the rifle. To ensure a high probability of hitting the target above the line, the marksman would deliberately aim the musket higher than the rifle.

Using N_{MIN} in the PBR equation effectively raises the aiming point to adjust for poorer precision in the abundance estimates. The amount above the line the marksman needs to aim depends on the number of shots below the line deemed acceptable. In management terms, how often can we fail to meet the management objectives and still consider the result acceptable? This is where the balance is struck between contradicting goals, such as keep populations at safe levels while minimizing hardship to fisheries. The translation between policy and science is achieved by defining specific quantitative objectives called performance criteria, so called because they are the performance standard for the model. This not only allows uncertainty to be incorporated but sets the management scheme in an explicit framework of acceptable levels of risk. Thus, parties that assert that the scheme is over- or underprotective must argue for different levels of acceptable risk rather than about the details of the science. Uncertainty can no longer be used as a reason for inaction.

Three performance criteria were used for this management scheme: (1) populations recovering from depletion (taken to be 30% K) will have a 95% probability of being above MNPL in 100 years; (2) healthy populations (≥MNPL) will have a 95% probability of remaining above MNPL after 20 years; and (3) populations at high risk (taken to be 5% K) will have a 95% probability of not delaying the time to reach MNPL by >10% over a zero human-caused kill scenario. All these criteria, like a population viability analysis, frame performance in terms of a certain probability of an event occurring in a given amount of time.

The performance criteria define for the marksman (modeler) how often shots must be placed above the line. This is accomplished in two steps by tuning the model to achieve the desired performance. The first step treats uncertainty related to imprecision in the abundance data. Consider the performance of criterion #1 that requires populations depleted to 30% of K to reach MNPL in 100 years. Simulations start with the initial population at 30% of K and "manage" the populations by simulating abundance

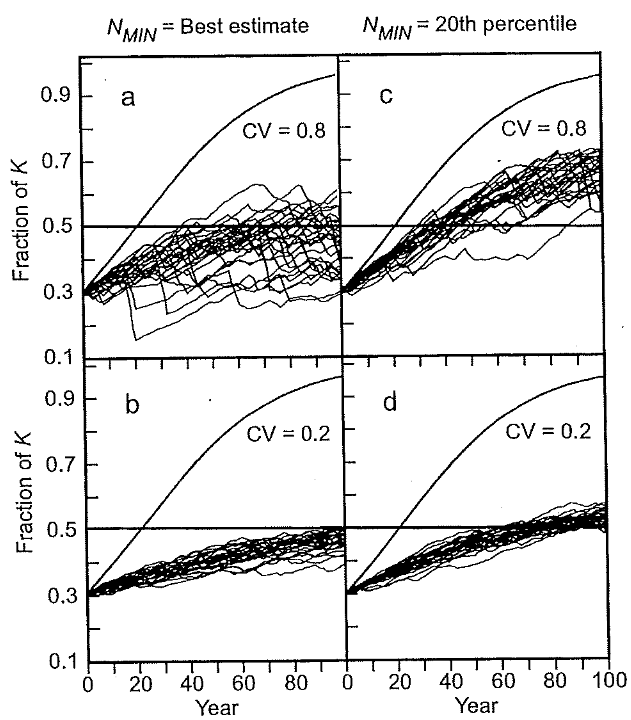

Figure 1. Thirty sample trajectories of populations recovering from a depleted level of 0.3 K. *In each case, the sigmoidal curve shows the expected trajectory with no human-caused mortalities, and the horizontal line at 0.5* K *shows the management objective of the maximum net productivity level. All cases use equation 2 with* $R_{MAX} = 0.04$ *(cetaceans) and* $F_R = 1.0$ *(no biases). Parts a and b assume* N_{MIN} *is the mean (best) abundance estimate (assuming the estimates are log-normally distributed). Parts c and d use the lower twentieth percentile of the abundance distribution as* N_{MIN}.

estimation, fisheries removal, and population growth for a range of plausible scenarios. For example, dolphin populations typically have a maximum growth rate of 4% per year and abundance estimates with coefficients of variation around 0.2. Sample trajectories for simulations vary (Fig. 1) because sometimes abundance is over- or underestimated, resulting in allowed kills that vary accordingly. Different percentages of the abundance estimate (N_{MIN}) are used, and the performance is measured by the proportion of time the population is ≥MNPL after 100 years. The percentage used for N_{MIN} is the one that results in the objective being met 95% of the time, which occurred at the lower twentieth percentile (Figs. 1c & 1d).

The simulations clearly show that accounting for uncertainty by using a lower percentile is precautionary, whereas the typical practice of the best estimate is not (Fig. 1). Figures 1a and 1b use the "best" abundance estimate for N_{MIN} in equation 2, and Figs. 1c and 1d use the lower twentieth percentile of the abundance estimate distribution for N_{MIN}. Using the "best" estimate manages less well-known populations (with lower precision abundance estimates) less conservatively (contrast Figs. 1a & 1b; see also Taylor 1993). Using a lower percentile of the abundance, in contrast, manages less well-known populations more conservatively (Figs. 1c & 1d). The reason that populations in Fig. 1c achieve on average a higher abundance than those in Fig. 1d is because the allowed kill is smaller. A fishery wishing to improve this situation may well request that more precise data are gathered. Thus, simply incorporating the uncertainty related to the precision of the abundance estimate met two management goals: increasing the margin of safety commensurate with the level of our ignorance of the population and providing an incentive to gather more precise data.

The second step in tuning the model is to address uncertainty caused by bias. Returning to the marksman analogy, bias would be indicated if shots aimed at a target consistently missed in one direction. If the sights are improperly adjusted, the marksman may aim above the line but consistently hit below it. The correction is to tune the sights.

We addressed this uncertainty using a second parameter, the recovery factor (F_R). After tuning the model to account for imprecision, we ran a second set of simulations to tune for potential biases in the key parameters: abundance, human-caused mortality, and maximum growth rate. For example, one scenario considered was overestimating the abundance by a factor of two. Such an overestimate could come from the relatively unlikely event of animals being attracted to the survey vessel or, more likely, from animals being included in the abundance estimate which were really part of another population. As a simple example, consider an exploited population of 1000 animals living adjacent to an unexploited population of equal size. Because we often cannot see population boundaries in the marine realm, these populations are accidentally treated as a single management unit. The result is that a kill is allowed that is about twice as high as it should be. The possibility of such errors led to the setting of default values for F_R such that 95% of the simulated populations equilibrated within OSP despite such errors. If the possible factors that cause bias are eliminated, this parameter could be raised to a value of one, but, doing so would dramatically reduce the safety margin for managing the species (Taylor 1997).

The final parameter in equation 2 is R_{MAX}. Using data from recovering populations, conservative default values were chosen when data were lacking or uncertain: 0.04 for whales and dolphins and 0.12 for seals and sea lions. Of course, data from the species or population of concern are used whenever available. Details of the simulations and rationale for default values are given by Wade (1998).

The result of including estimates of precision in calculating the PBR is that the expected equilibration level increases as the CV of the abundance estimate increases (the precision decreases) (Fig. 2), which is necessary to ensure meeting management goals with less precise data. The point where the PBR lines intersect the net productivity curve is the level at which the population is expected to equilibrate.

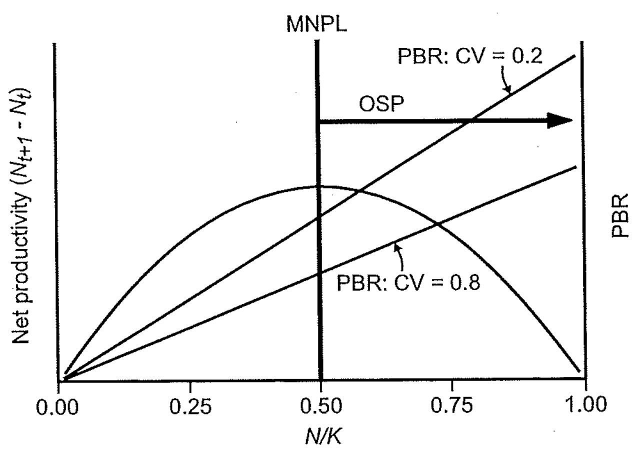

Figure 2. Net productivity and potential biological removal (PBR) for different levels of abundance/carrying capacity (N/K) with the same scale. Populations would be expected to equilibrate at the intersection point between the lines for PBR and the net productivity curve. These PBRs do not include the safety factor (F_R), which would reduce PBRs to half for threatened or depleted stocks or stocks with unknown population structure or to one-tenth for endangered species. Maximum net productivity level (MNPL) is assumed to be at 0.5 K (vertical line). The objective is to keep populations above MNPL, which would then be called optimum sustainable populations (OSP) (horizontal arrow).

We have addressed treatment of scientific uncertainties, but in management the uncertainty in the implementation of a management scheme cannot be overlooked. The PBR management scheme flags populations that may be experiencing unsustainable mortality and gives a target level of acceptable mortality. The PBRs are calculated for each stock by federal government scientists and are presented in stock assessment reports. These reports are reviewed by three regional "scientific review groups," bodies of nonfederal scientists representing perspectives of state agencies, academia, fisheries, and environmental groups, who make recommendations on research priorities and the adequacy of the data used. Stocks for which estimated fishery-caused mortality exceeds PBR are termed *strategic*. Regulations are not automatically imposed on fisheries when kills exceed the PBR. Instead, data are scrutinized for the potential that biases can be reduced by improving abundance estimates or stock definitions. Several species originally listed as strategic have been removed from the list as dedicated research was conducted to correct for suspected biases. If, however, the data are sound and fisheries contribute significantly to mortalities in strategic stocks, a "take reduction team" is formed. The team, composed of fishers, environmentalists, state and federal government representatives, and scientists, is charged with the task of recommending means to reduce the kills (take) to levels at or below PBR within 14 months subsequent to the finalization of the stock assessment reports.

Results of Current Management Model

After the first year of implementation (1994), stock assessment reports were written for 153 stocks in U.S. waters, and PBRs were published for 89 stocks (Barlow et al. 1995*a*; Blaylock et al. 1995; Small & DeMaster 1995) (Table 2). For 22 additional stocks, PBRs were not published but either an approximate PBR level or a lack of evidence for any human-caused mortality allowed the stock to be classified, resulting in 112 out of 153 stocks (73%) being assessed. Kills exceeded PBR for 24 stocks of marine mammals. Although some of these, such as harbor porpoise in the Gulf of Maine, were known to be at risk before the management scheme was instituted, many were species that had received no attention in the past. Chief among these were species of whales that spend long periods of time beneath the surface, including sperm whales (*Physeter macrocephalus*) and numerous beaked whales (Family *Ziphiidae*).

The stock assessment reports reveal both stocks that are at risk and gaps in what we need to know to manage properly. Comprehensive surveys off the Pacific and Atlantic coasts were completed in 1996 and 1998, respectively. Because the law mandates monitoring, surveys are planned to continue on a rotational schedule. Testing of the scheme has also made clear the importance of understanding population structure and genetic sampling, which are becoming an integral part of survey design. Knowing the spatial distribution of kills allows formulation of stock boundary hypotheses needed to interpret genetic data (Taylor & Dizon 1996; Taylor 1997). Take reduction teams have been formed, and research is underway to develop techniques to reduce the number of marine mammals killed in fisheries to as near zero as is practicable.

Comparisons between the Models

The fundamental problem when management involves potentially limiting human-caused mortality is determining the acceptable level of kill. The old model attempted to do this by determining the status of the population relative to *K*. The model failed as a management technique and provided little improvement in our scientific understanding of marine mammal biology. Recognizing our inability to estimate MNPL for most species, we turned to using trends in abundance as an indicator of population health. Using trends has two important limitations. First, the burden of proof is nearly always to prove that the population is declining (Thompson et al., this issue). Low precision in abundance estimates makes such proof so difficult that management actions cannot take place before populations become severely depleted. Although

Table 2. Summary of the number of marine mammal stocks by region that were assessed in 1995 by the National Marine Fisheries Services under the potential biological removal (PBR) management scheme.

Region	*Stocks*	*PBR and mortality*[a]	~PBR and mortality[b]	No PBR but no mortality[c]	Total assessed[d]	Source
Alaska	35	20	0	7	27	Small & DeMaster 1995; NMFS 1995
Atlantic	62	40	8	5	53	Blaylock et al. 1995; NMFS 1995
Pacific	56	29	1	2	32	Barlow et al. 1995*a*; NMFS 1995
Total	153	89	9	14	112	

[a] *Number of stocks for which PBR and total human-caused mortality were calculated.*
[b] *Number of stocks for which PBR was not calculated but for which an approximate PBR level was available along with a calculation of total human-caused mortality.*
[c] *Number of stocks for which no PBR was calculated but for which there was no known human-caused mortality.*
[d] *Sum of the previous three categories.*

there is the potential of either shifting the burden of proof or reducing the level of proof needed to show a decline (raising the α level), there is still the problem of interpreting the cause of the decline and whether the decline is acceptable or not. Consider, for example, a demonstrated decline of 40%. Even if a 40% decline was considered acceptable, as it would be under the PBR scheme, biologists would still need to determine whether the decline was likely to continue and what part of that decline, if any, was a result of human-caused mortality.

The PBR approach is much more direct because it monitors the factor (human-caused mortality) that may need management. Rather than waiting until a population has been depleted to begin taking action, the PBR approach starts reducing mortality when it is apparent that current kill levels will lead to depletion. Yet the approach does require an estimate of kill, which is not an easy task. Estimating human-caused mortality is likely to be difficult for both marine and terrestrial species. Gathering data is likely to be costly if the mortalities are a result of low impact by many people. In our case, estimates are especially poor for fisheries with large numbers of small boats, often operated by one person. Assuring adequate coverage would require a much higher level of funding than is currently allocated to this problem. Insufficient funding is connected to the second general problem: obtaining funding for scrutiny of private enterprise is not politically popular. Although the estimation procedure is difficult, it is unwise to rely on reports from the resource users, and it is clear that management cannot succeed without some estimate of the number of animals being killed. Some creative thinking about how to estimate human kills is desperately needed to understand the magnitude of human impact on wild populations.

The definition of management units has stymied both past and current management. Understanding population structure is fundamental to any management scheme but remains at or beyond our scientific limits. The International Whaling Commission uses a precautionary approach by defining "small areas." These areas are created to be so small that biologists believe it is not possible to have more than one population in that area. Although this approach is precautionary and requires only rudimentary knowledge of the populations, it is also controversial because no standard exists to determine when evidence is sufficient to justify increasing the size of small areas.

The original PBR guidelines (Barlow et al. 1995*b*; Wade & Angliss 1997) essentially tried to make initial management units equivalent to small areas. Scientists from different regions, however, did not agree with this definition and created their own definitions. Some felt it beyond their prerogative as scientists to draw lines on a map when data were few to nonexistent. But refusing to draw boundaries does not leave the management as "undefined" with no kills allowed but rather defines the management unit as the range of the species and puts the burden on scientists to prove that population structure exists before any management actions will be taken.

The success of this management scheme depends in large part on proper definition of stocks or use of F_R to account for potential biases. If stocks are defined in large units, such as the entire Pacific coast, it is likely that localized fisheries will never exceed PBR; therefore, any management actions needed to preserve the integrity of the range would not occur. Obtaining measures of population structure for marine mammals is difficult because their aquatic nature limits access for research. Requiring proof of structure means at least lengthy delays until management units are adequately defined. Indeed, requiring such proof may make the new management scheme as ineffective as the old scheme for some species, because a required parameter is essentially impossible to estimate.

Discussion

The history of marine mammal management clearly demonstrates the need to incorporate uncertainty into management models. Simple biological models, which did not incorporate uncertainty, resulted in inaction or failed management. The model now used to manage marine mammal populations in the United States is simple enough for both the regulators and the regulated to understand, it relies on parameters that can be estimated, and it rewards the reduction in uncertainty with less conservative management while allowing management actions despite uncertainty. By mandating monitoring of both abundance and human-caused mortality, we have already greatly increased our general knowledge of marine mammal populations and identified unsuspected at-risk species and stocks that otherwise would have been missed.

One of the most positive aspects of the new management scheme is separating science from policy through the use of performance criteria. Parties on either side of management decisions may disagree with the criteria. For example, some may want populations to remain at higher levels, whereas others may be satisfied with a higher chance of not meeting management objectives. Neither party, however, is likely to disagree with the estimated level of precision of abundance estimates or use this uncertainty as a rationale for not taking action until uncertainty is removed.

One of the most argued parts of the model is the default used for F_R. This default was set at 0.5 to account for unknown biases based on the results of simulation trials. It is difficult to set a value objectively for an unknown bias. Although quite a large bias (e.g., only one-half of the kills reported or the abundance estimated as twice the true abundance) would be needed before any single factor resulted in failure to meet management objectives, rather small biases in several factors would lead to the need for $F_R = 0.5$ to meet management objectives. It is possible to raise F_R by presenting evidence that biases in abundance, stock structure, growth rate, and kills are unlikely or very small. Setting $F_R = 1.0$ allows no room for bias in any of these factors.

The simplicity of the management model may trouble ecologists who are used to models of ecosystems. The number of parameters needing estimation for an ecosystem model make such models unlikely to be useful as direct management tools. Indeed, the first 20 years of management under the MMPA failed because of the inability to estimate parameters for a fairly simple model. Although the marine mammal management model is simple, it seems to gather the baseline data for all species and affect management of some fisheries interaction problems. There are also marine mammal populations experiencing declines that cannot be explained by incidental fisheries kills, such as the ongoing decline of Steller sea lions (*Eumatopias jubatus*). More complex biological models will continue to help us understand the causes for these declines and may eventually result in modifications to the management model to address such factors as reduced growth rate caused by competition for fish with humans. In the meantime, we have a working management scheme that addresses one major risk factor for marine mammals: direct human-caused mortality.

Many other terrestrial and marine species are also at risk from direct human-caused mortality. For such species, a simple management model such as the PBR scheme, may allow adequate management despite many uncertainties about a particular species. At a minimum, managers must have estimates of abundance (and its precision) and of human-caused mortality. It is important for managers to realize that successful management of human-caused mortality must be based on these data at a minimum. It is remarkable how few long-term programs are in place to monitor abundance, yet it is difficult to imagine a more essential piece of information for good management. It is also important for research to be dedicated to estimating human-caused mortality because history has clearly demonstrated the inadequacy of relying on reports generated by the potentially affected resource users. Carefully chosen defaults can be used for parameters concerning maximum population growth rate and population structure. The PBR scheme required setting quantitative management objectives and has yielded a clear measure of performance: PBR versus the estimated kill. Reducing human-caused mortality to levels below PBR also gives the concerned parties a clear goal around which to organize both further research and conservation actions.

Indirect and direct human-caused mortality pose the greatest risks to marine species, and we have directed our management efforts accordingly. Habitat loss may pose greater risks for the management of terrestrial species. Although the problems may differ, the following general lessons from our marine experience apply: (1) models must be based on parameters that are easily estimated; (2) uncertainty should be directly incorporated not only so management can proceed despite uncertainty but so that management is more conservative the greater the uncertainty; and (3) management objectives should be quantitatively defined as performance criteria to both separate science from policy and allow the management models to be tuned by means of simulations.

Acknowledgments

We thank our many colleagues in the National Marine Fisheries Service for the years of experience studying marine mammals that led to the realization of the knowledge we are likely to gain in our scientific lifetimes. Thanks to S. Reilly, E. Edwards, K. Ralls, and two anonymous reviewers. Our salaries were paid by the National Marine Fisheries Service and the Office of Protected Resources within that agency.

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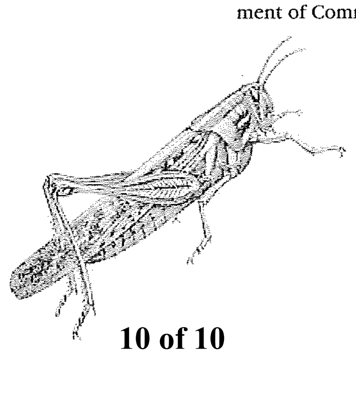

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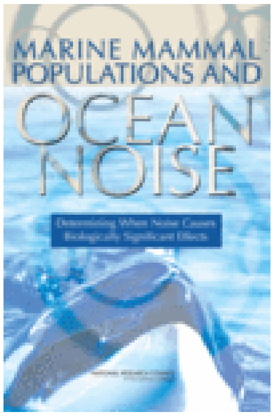

Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects

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ISBN: 0-309-54667-2, 142 pages, 6 x 9, (2005)

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This study was supported by Grant No. N00014-03-1-0886 between the National Academy of Sciences and the National Oceanographic Partnership Program with support from the National Oceanic and Atmospheric Administration, Office of Naval Research, National Science Foundation, and the Minerals Management Service. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the organizations or agencies that provided support for the project.

International Standard Book Number: 0-309-09449-6 (Book)
International Standard Book Number: 0-309-54667-2 (PDF)

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COMMITTEE ON CHARACTERIZING BIOLOGICALLY SIGNIFICANT MARINE MAMMAL BEHAVIOR

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Preface

Biologically significant is an easy modifier to insert into many descriptors, from habitat designations to pharmacological reactions. It has the attributes of a perfectly reasonable modifier. After all, who would object to putting a limit on the great panoply of varied habitats or potential responses encountered in nature? However, when one attempts to distinguish between biologically significant and biologically not significant, the first question is, To whom? The initial choice of range—from habitat to pharmacology—implies the breadth with which this modifier has been used. Biologically significant changes at the habitat level imply alterations in the composition of species that use a habitat. Biologically significant changes at the pharmacological level imply organism changes. Intermediate between those levels are the population (or stock in marine mammal management terms) and the species.

The most basic goal of the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1361) is to maintain marine mammals as a "significant functioning element in the ecosystem of which they are a part." The MMPA translates that ecosystem goal to the population level by aiming to ensure that marine mammal stocks do not fall below or are restored to their optimal sustainable population sizes. Although the main goals of the MMPA are defined at the ecosystem and population levels, its primary focus of regulation is at the level of the individual. When the MMPA was enacted, marine mammal populations were threatened by hunting and by deaths resulting from becoming entangled in nets or otherwise killed in fisheries. The primary regulatory mechanism in the MMPA was a prohibition of the taking of marine mammals; where "take" means to harass, hunt, capture, or kill or attempt to harass, hunt, capture, or kill any marine mammal. The prohibition of taking has reduced the death and injury of marine mammals enough that today many important threats involve habitat degradation and the cumulative effects of harassment. Although harassment is included as a prohibited taking in the MMPA, this prohibition has proved ill suited for protecting marine mammal habitat and regulating cumulative effects.

One approach for protecting marine mammals might be to monitor their populations and initiate protective measures for populations in decline. However, we cannot estimate trends precisely for most marine mammal populations, and by the time a decline is detected, it may be too late. In addition, we also need methods to determine which human activities or natural phenomena are causing population declines or inhibiting population recovery. Many effects of human activities on individual marine mammals occur on a time scale of seconds to years, effects on populations on a scale of years to generations, and effects on ecosystems on a scale of generations to centuries. This report focuses on changes at the population level, but what can be observed are the much faster changes in the behavior and physiology of individuals. The basic goal of this report is to explore the scientific challenge of using short-term observations at the level of individuals to predict effects on populations. Such a predictive model would serve two functions: identifying when the cumulative sum of human effects poses a risk to a population and identifying the activities that pose the greatest risk.

What little we know about behavioral responses of marine mammals to anthropogenic noise highlights the importance of context, including the demographic status of the animals receiving the sound; the characteristics, location, and movement of the sound source; and the location of the animals. The history of the animals is also important: prior exposure to the sound could have resulted in habituation or sensitization. Context includes population status and ecosystem changes; responses that would be insignificant in a population near its carrying capacity can become significant in populations that are depleted or that are encountering multiple stressors, such as El Niño.

Our glimpses into the lives of marine mammals are so short that it is difficult to determine whether the small part of a behavioral reaction we usually can observe is biologically significant. In contrast with Supreme

Court Justice Potter Stewart's statement with respect to pornography, "I know it when I see it" (Jacobellis v. Ohio, 378 U.S. 184, 197 [1964]), the problem in determining the biological significance of marine mammal responses is that often we do *not* know them when we see them. Marine mammals are so hard to observe that we may never see serious problems without studies that are targeted to understand their normal behavior and physiology in the wild. A basic tenet of responsible management and conservation is the need to balance the risks posed by overregulation and those posed by underregulation; the latter carry more weight in conditions of greater uncertainty. The depth of our uncertainty in these issues can make it difficult to calibrate the proper extent of precaution.

A reader who expects this volume to provide a "Eureka" moment of insight into the biological significance of marine mammal responses to noise will be disappointed. That should not come as a surprise. Biological significance has not been well defined in many animal groups that are much more amenable to observation than marine mammals and on which much more data are available. The last few decades have seen a rapid increase in studies of the responses of marine mammals to noise, and there is growing evidence that some sounds play a role in lethal strandings of deep-diving beaked whales, but there is not one case in which data can be integrated into models to demonstrate that noise is causing adverse affects on a marine mammal population. In the case of strandings, the primary data gaps are in our ignorance of the population size and status of beaked whales, and our uncertainty about the number of animals killed or injured. For most other noise effects, the primary source of uncertainty stems from our difficulty in determining the effects of behavioral or physiological changes on an individual animal's ability to survive, grow, and reproduce.

This report contains a conceptual model designed to serve as a roadmap for developing a predictive model that will relate behavioral responses caused by anthropogenic sound to biologically significant, population-level consequences. It identifies the extent of current knowledge and data gaps in each component of the proposed conceptual model to show where research is most needed. In addition to pointing toward a decade-long research agenda for the predictive model, the report suggests management alternatives for the short term and the intermediate term. It also recommends changes in the regulatory structure to include effects of sound on marine mammals within the broader management structure now used exclusively for fisheries. The goal is a common metric for the impact of all human activities on marine mammals and consistent regulation of that impact.

Although a model for predicting the biological significance of different effects cannot be created today, this report offers an approach that can be implemented now to identify, within specified limits, when the responses of marine mammals to anthropogenic noise do not rise to the level of biological significance. The first step in dealing with an apparently intractable problem is to bound it, and this report describes a method for doing that.

Acknowledgments

This report was greatly enhanced by the participants in the workshop held as part of the study. The committee would first like to acknowledge the efforts of those who gave presentations at meetings and thereby helped to set the stage for fruitful discussions in the closed sessions that followed:

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This report has been reviewed in draft form by persons chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards of objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following for their participation in their review of this report:

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Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by **John Dowling**, Harvard University, and **Andrew Solow**, Woods Hole Oceanographic Institution, appointed by the National Research Council, who were responsible for making certain that an independent examination of the report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of the report rests entirely with the committee and the institution.

Contents

Executive Summary

The transition from wind-driven to mechanized shipping became the first step in what was to be a continued increase in the introduction of sound into the oceans. The oceans are much less transparent to light than to sound; as a result, many marine species use sound rather than light to navigate and communicate. Over the last 40 million years, marine mammals have evolved specializations for using underwater sound. The initial introduction of the propulsion sound of ships was unintentional, but engineers and scientists have also learned, with the development of sonar, how to use sound intentionally for underwater communication, navigation, and research. At some point as humans introduce more sound into the oceans, the conflict with evolutionarily-adapted marine mammal sound-sensing systems seems inevitable. Attention has been drawn to this issue through a series of marine mammal strandings, lawsuits, legislative hearings, and National Research Council (NRC) reports (1993, 2000, and 2003b) and, most recently, the draft report of the US Commission on Ocean Policy (2004).

Two earlier National Research Council reports (1994, 2000), while addressing biological issues of marine mammals and noise, also made recommendations that affected federal legislation and its implementation. The first was issued in 1994 in response to the feasibility test of a proposal to track global warming by monitoring the speed of an acoustic signal across an ocean basin (Munk et al., 1994). The feasibility test was to have set the stage for the full Acoustic Thermometry of the Ocean Climate (ATOC) experiment, but because of concerns over possible effects on marine mammals only a limited deployment of ATOC was attempted. The 1994 report recommended that there be legislative distinction between different types of "taking" and that the regulatory agencies streamline the permitting process for activities that did not kill or capture marine mammals. Additional streamlining was recommended for nonlethal activities that have negligible effects. The 2000 National Research Council report reviewed the marine mammal research program that was a component of the limited ATOC deployment. In *Marine Mammals and Low-frequency Sound: Progress Since 1994*, the committee noted that the 1994 amendments to the Marine Mammal Protection Act (MMPA) addressed some of the issues raised in the 1994 NRC report. The 1994 amendments introduced two levels of takes by harassment under the MMPA—level A and level B harassment. Level A harassment was defined in the 1994 amendments as "any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild." Level B harassment was defined as "any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering." However, the 2000 National Research Council report emphasized the importance of a criterion for significance of disruption of behavior (pg. 68):

> It does not make sense to regulate minor changes in behavior having no adverse impact; rather, regulations must focus on significant disruption of behaviors critical to survival and reproduction.

The report (pg. 69) recommended redefining level B harassment as any act that

> has the potential to disturb a marine mammal or marine mammal stock in the wild by causing meaningful disruption of biologically significant activities, including but not limited to, migration, breeding, care of young, predator avoidance or defense, and feeding.

Since the report was issued, the term *biologically significant* has been used in discussions of the 2003-2004 reauthorization of the MMPA (House Report 108-464). The US National Marine Fisheries Service (now National Oceanic and Atmospheric Administration [NOAA] Fisheries) has also used the term in decisions to grant incidental harassment authorizations. Scientific investigation and description of what would constitute "biologically significant" have not been pursued in a comprehensive manner.

The charge to the present National Research Council committee (Box ES-1) was to clarify the term *biologically significant*. In the broadest sense, it is a straightforward charge. An action or activity becomes biologically significant to an individual animal when it affects the ability of the animal to grow, survive, and reproduce. Those are the effects on individuals that can have population-level consequences and affect the viability of the species. However, those effects are separated in time and usually in space from the precipitating event. What can be observed, with difficulty in the case of marine mammals, are the direct behavioral and in some cases physiological responses of individual animals.

It was recognized that the definition of level B harassment proposed in the 2000 report introduced two kinds of biological significance: one with respect to animal activities, stated directly, and the other implied in the "meaningful disturbance" of those activities. On reflection, it became clear that wild animals rarely engage in activities that are not biologically significant (even play is not frivolous [Bekoff and Byers, 1998]), so the primary

BOX ES-1
Statement of Task

In its 2000 report, *Marine Mammals and Low-frequency Sound*, the National Research Council recommended that the Marine Mammal Protection Act definition of "Level B harassment should be limited to meaningful disruption of biologically significant activities that could affect demographically important variables such as reproduction and longevity." Recognizing that the term "biologically significant" is increasingly used in resource management and conservation plans, this study will further describe the scientific basis of the term in the context of marine mammal conservation and management related to ocean noise. Based on input from a scientific workshop, consideration of the relevant literature, and other sources, the committee will produce a brief report that reviews and characterizes the current scientific understanding of when animal behavior modifications induced by transient and non-transient ocean acoustic sources, individually or cumulatively, affect individuals in ways that have negative consequences for populations.

concern should be with determining when human activity elicits behavioral or physiological responses in marine mammals that rise to the level of biological significance.

Changes in behavior that lead to alterations in foraging efficiency, habitat abandonment, declines in reproduction, increases in infant mortality, and so on are difficult to demonstrate in terrestrial animals, including humans, and are much more difficult to demonstrate in animals that may only rarely be observed in their natural environment.

A CONCEPTUAL MODEL TO ADDRESS POPULATION CONSEQUENCES OF ACOUSTIC DISTURBANCE

A conceptual model is proposed that identifies the different stages required to move from marine mammal behavior to a determination of population effects of behavioral change. The model first characterizes an acoustic signal, the resulting behavioral change, and a determination of the "life function" or activity affected. It then describes the resulting change in vital rate, such as life span, and finally suggests population effects—effects on following generations. "Transfer functions" connect the variables. A transfer function is essentially a relationship that allows one to estimate, for example, how a change in migration route leads to a reduction in reproductive success. It was quickly recognized that the high-priority research identified in the earlier National Research Council reports (1994, 2000, 2003b) is essential for building the first stages of the model.

RECOMMENDATION 1: The high-priority research identified by the National Research Council (1994, 2000, 2003b) should be completed. That research is essential for the model proposed in this report.

Through discussions before and during the public workshop held at the National Academies in March 2004, a consensus was reached that the proposed conceptual model includes the components needed to develop a predictive model to determine the biological significance of behavioral change. However, there was also a consensus that we are a decade or more away from having the data and understanding of the transfer functions needed to turn such a conceptual model into a functional, implementable tool.

RECOMMENDATION 2: A conceptual model, such as that described in this report, should be developed more fully to help to assess impacts of acoustic disturbance on marine mammal populations. Development of such a model will allow sensitivity analysis that can be used to focus, stimulate, and direct research on appropriate transfer functions.

To enhance such a model and progress toward determining population effects of acoustic disturbance, all available sources of data on marine mammal behavior and reactions to noise will need to be accessed. In addition to results of normal scientific studies, a veritable wealth of data on marine mammals is collected in compliance with federal regulatory requirements, but those data are not being accessed or used beyond the original intent of their collection (such as for permit issuance). A data-coordination effort could provide substantial benefits and improve our knowledge of marine mammal distribution, critical habitats, behaviors, population estimates, and other items essential for the modeling effort. Although data coordination would be difficult to implement, over the long term the value added by improving the organization and accessibility of data collected for these purposes would provide an efficient means of extracting invaluable information, at relatively small additional cost, for improving understanding and management. Such leveraging of diverse data collection efforts would represent an efficient use of resources and public funding. For example, the UK Joint Natural Conservation Committee has summarized sighting data from commercial seismic surveys, which help in evaluating avoidance responses (Stone, 2001, 2003).

RECOMMENDATION 3: To assist in the development of the conceptual model, a centralized database of marine mammal sightings and their responses to anthropogenic sound in the ocean should be developed and should include

- **Published peer-reviewed papers in the scientific literature.**
- **Government technical reports.**
- **Data submitted to NOAA Fisheries and the US Fish and Wildlife Service in permit applications.**
- **Data submitted by industry to the Minerals Management Service for regulating off-shore hydrocarbon exploration and production.**

- **All relevant data accumulated by all federal agencies in the course of their research and operational activities, including monitoring.**

To facilitate the integration of data from the various sources, federal agencies need to develop standardized data-reporting formats. Survey data should include locations where marine mammals were detected and the track lines when personnel were monitoring for marine mammals, regardless of whether any were sighted. All data entered into such an integrated database must be coded as to quality, and peer-reviewed data and interpretations should be rated highest.

The biological significance of the behavioral response of an animal to an acoustic stimulus is modulated by many seasonal and environmental factors. For example, the lengthening of a foraging trip from a rookery that would be of no particular significance during a normal year could rise to the level of biological significance during an El Niño year. Allostasis, the maintenance of an animal's physiological stability in spite of change, is a useful way to conceptualize the integration of short-term and cumulative stress and thereby to determine the possible additional effects of anthropogenic noise on marine mammals. Although data for marine mammals are lacking, serum hormone concentrations have been shown to be good measures of stress in terrestrial animals. For animals in which blood sampling is impractical, fecal sampling has been used successfully and is now being applied to some marine mammals. Preliminary studies measuring glucocorticoids in hair samples and enhanced synthesis of RNA coding for stress-induced proteins in skin samples merit further development. Measures of stress may provide critical information on marine mammal physiological status and change in response to disturbance by acoustic and other stimuli.

Correlational observations of behavioral responses to noise and other stressors have indicated general trends in such responses and in some cases have highlighted subjects of concern. To calibrate an animal's response to a stimulus as required for a predictive model, correlational observations must be replaced with controlled-exposure, dose-response experiments. Such an approach allows researchers to go beyond observational study and determine statistically the likelihood of a particular reaction to a given acoustic stimulus. In marine mammals, such experiments are only beginning to be conducted. There is a potential for collecting both behavioral and physiological data during controlled-exposure experiments. The resulting data will be essential for integrating behavior and physiology in models of the population consequences of acoustic disturbance.

Additional development of data-logging technology is necessary for support of controlled-exposure experiments. Data-logging packages should be modified to incorporate blood sampling during controlled-exposure experiments. Initial studies on Weddell seals (*Leptonychotes weddellii*) would be particularly useful in as much as research on their blood chemistry during free dives has already been conducted (Hill, 1986). Eventually the packages would benefit from new less-invasive methods for collecting blood and conducting "on-board" blood-chemistry analysis to record responses of animals in situations less unusual than that of the Weddell seal—a situation in which the animal can be handled before and after tagging.

RECOMMENDATION 4: The use of glucocorticoid and other serum hormone concentrations to assess stress should be developed, validated, and calibrated for various marine mammal species and age-sex classes and conditions. Dose-Response curves for those indicators as a function of sound characteristics need to be established. Development of a sampling package that could take blood samples on a controlled basis and stabilize hormones for later analysis or process samples "on-board" for corticosteroids at various stages of a CEE would be invaluable for determining the stress that the sound is producing. The use of fecal sampling to measure condition or stress needs to be investigated further and developed. Research efforts should seek to determine whether reliable long-term stress indicators exist and, if so, whether they can be used to differentiate between noise-induced stress and other sources of stress in representative marine mammal species (this recommendation was also made in NRC, 2003b).

Although the full predictive model of the path from acoustic stimulus to population effect is unattainable in the near term, various modeling techniques can enhance our understanding of the components of the larger model. One approach involves demographic models in which age- or stage-specific developmental, behavioral, or physiological characteristics of individuals are used to explore changes in population dynamics (Caswell, 2001). Another approach involves individual-based models that can be used to infer population responses by tracing the life history of individuals. For a number of nonmarine mammal species, individual-based models include physiology and behavior; such models have provided insight into how ecological change and human disturbance have altered demographic variables. Although a thorough, detailed model is not now possible for any marine mammal species, this approach can be used to provide preliminary understanding and to identify the most crucial gaps in available data.

Qualitative or categorical modeling that characterizes the strength of links between stimulus and response, response and function, and function and demography on a simple low-medium-high basis can be useful. A focused effort is needed on a modeling exercise that should include quantitative demographic models, individual-based models, and qualitative categorical models. Such an effort should start with, and be calibrated against, expert opinion. The effort should

- Probe how successfully current knowledge could be applied.
- Identify crucial gaps in our knowledge.
- Encourage and provide structure for interdisciplinary synthesis.
- Require that all modeling efforts be explicit about uncertainty and the consequences of uncertainty.
- Require that all models clearly state their limited purpose and evaluate both their strengths and their shortcomings.
- Assess the risk for the species being modeled if the model is to be used for management decisions.

Exploratory models could help to bridge the gap between changes in the physiology and behavior of individuals in response to sound and demographic effects at the population level. Demographic models might be used in an exploratory way to help to bound the problem and establish thresholds for different species. Individual-based models may provide a method for exploring the consequences of changes in individual behavior and social interactions. Those modeling approaches could be used, individually or in combination, to provide greater understanding of the problem, look for important thresholds, speculate on the likely outcome of hypothesized changes, and develop a conceptual framework for formulating management guidelines.

RECOMMENDATION 5: Several marine mammal species for which there are good long-term demographic and behavioral data on individuals should be selected as targets of an intensive exploratory modeling effort that would develop a series of individual-based models and stage- or age-structured demographic models for the species as appropriate. NOAA Fisheries should bring together an independent, interdisciplinary panel of modelers and relevant empirical scientists that would meet periodically to pursue the modeling effort collaboratively in an iterative and adaptive manner with the long-term goal of developing tools to support informed, practical decision-making.

As noted, the full predictive model is at least a decade away from coming to fruition, and the management requirements involved in addressing concerns over ocean-noise effects on marine mammals are extremely pressing. Efforts are under way to address the long-term goal of producing the predictive model outlined here, but an interim plan is needed. One strategy is to implement a management regimen that uses available data, agreed upon management goals, and a conservative approach to the insufficiencies of the available data. The regimen should encourage data acquisition to reduce uncertainty. The NOAA Fisheries Potential Biological Removal (PBR) model is such an example.

RECOMMENDATION 6: A practical process should be developed to help in assessing the likelihood that specific acoustic sources will have adverse effects on a marine mammal population by disrupting normal behavioral patterns. Such a process should have characteristics similar to the Potential Biological Removal model, including

- **Accuracy,**
- **Encouragement of precautionary management—that is more conservative (smaller removal allowed)—when there is greater uncertainty in the potential population effects of induced behavioral changes,**
- **Being readily understandable and defensible to the public, legal staff, and Congress,**

- **An iterative process that will improve risk estimates as data improve,**
- **Ability to evaluate cumulative impacts of multiple low-level effects, and**
- **Construction from a small number of parameters that are easy to estimate.**

The PBR model has the potential for being applied more widely than it is now. So far, for most species it has incorporated only direct fishery mortalities and serious injuries in the determination of biological removal. Indirect fishery mortalities, nonfishery mortalities, and mortality equivalents for injury and disruption need to be added to the biological removal in the model to encompass the multitude of effects, including acoustic effects, of human activities on marine mammal populations.

RECOMMENDATION 7: Improvements to PBR are needed to reflect total mortality losses and other cumulative impacts more accurately:

- **NOAA Fisheries should devise a revised PBR in which all sources of mortality and serious injury can be authorized, monitored, regulated, and reported in much the same manner as is currently done by commercial fisheries under Section 118 of the MMPA.**
- **NOAA Fisheries should expand the PBR model to include injury and behavioral disturbance with appropriate weighting factors for severity of injury or significance of behavioral response (cf. NRC, 1994, pg. 35).**

Current knowledge is insufficient to predict which behavioral responses to anthropogenic sounds will result in significant population consequences for marine mammals. The predictive model and even the proposed revisions to PBR will take years to implement. In the interim, those who introduce sound into the marine environment and those who have responsibility for regulating sound sources need a system whereby reasonable criteria can be set to determine whether a particular sound source will have a non-significant effect on marine mammal populations. Collectively, there is sufficient expert knowledge and there are extensive databases to establish such a system and to set the criteria conservatively enough for there to be broad agreement on the nonsignificant effect criterion. An example of a preliminary application of the approach is the impact-likelihood risk-evaluation matrices developed for typical acoustic equipment used on research vessels in the Antarctic (SCAR, 2004).

RECOMMENDATION 8: An intelligent-decision system should be developed to determine a de minimis standard for allowing proposed sound-related activities. An expert-opinion panel should be constituted to populate the proposed system with as many decision points as current information and expert opinion allow. The system should be systematically reviewed and updated regularly.

The goal of this report is to provide a method for clarification of the concept of biologically significant disturbance. The recommendations made here are intended to provide both a long-term, well-supported, and valid solution and a near-term problem-solving strategy to assist resource managers in coping with this difficult and complex issue.

1

Introduction

DEFINING THE PROBLEM

Throughout human history, the oceans have been important for transportation and commerce, for their biological and physical resources, and for defense. The vast expanse of the oceans precluded significant human impact until the coming of the industrial revolution when the transition from wind-driven to mechanized shipping became the first step in what was to be a continued increase in the unintentional and then—with the development of sonar—intentional introduction of sound into the oceans. Because of the low loss characteristic of sound transmission compared with light transmission, the use of sound had developed evolutionarily as the predominant long-range sensory modality for marine mammals. As engineers and scientists learned to appreciate the properties of acoustic propagation in the sea, they introduced sound sources to communicate and to detect objects in the oceans or on or below the seafloor. At some point, as humans use the oceans more and increase anthropogenic sound in the oceans, the conflict with evolutionarily adapted marine animals' sound-sensing systems seems inevitable.

Over 90% of global trade uses the sea for transportation. Shipping is the dominant source of sound in the world's oceans in the range from 5 to a few hundred Hertz. At other frequencies, anthropogenic sound does not predominate in the ocean sound-energy budget, but it can have important local effects (NRC, 2003b). Seismic air guns associated with geophysical exploration for locating new oil and gas deposits run hundreds of thousands of miles of survey lines in the Gulf of Mexico alone each year. Commercial sonar systems are on all but the smallest pleasure craft and permit safer boating and shipping and more productive fishing. Military sonar systems are important for national defense. Ocean noise from human and natural sources can also originate in the air, as in sonic booms, lightning, and wind (NRC, 2003b).

The intentional and unintentional introduction of sound in the oceans associated with activities beneficial to humans has known deleterious effects on individual marine mammals. Mass strandings of beaked whales, defined as strandings involving two or more animals other than female-calf pairs (Geraci and Lounsbury, 1993), in some cases have clearly been associated with the use of midrange tactical military sonar (D'Amico, 1998; Evans and England, 2001; Jepson et al., 2003). Beluga whales (*Delphinapterus leucas*) have strong and prolonged behavioral responses to icebreakers 50 km away under some circumstances (LGL and Greeneridge, 1986; Cosens and Dueck, 1988; Finley et al., 1990). Gray whales (*Eschrichtius robustus*) and killer whales (*Orcinus orca*) have shown multiyear abandonment of critical habitats in response to anthropogenic noise (Bryant et al., 1984; Morton and Symonds, 2002). Although there are many documented, clearly discernible responses of marine mammals to anthropogenic sound, responses are typically subtle, consisting of shorter surfacings, shorter dives, fewer blows per surfacing, longer intervals between blows, ceasing or increasing vocalizations, shortening or lengthening vocalizations, and changing frequency or intensity of vocalizations. Some of those changes become statistically significant for a given exposure, such as increases in descent rate and increases or decreases in ascent rate of northern elephant seals (*Mirounga angustriostris*) in response to Acoustic Thermometry of the Ocean Climate (ATOC) signals (Costa et al., 2003). But it remains unknown when and how these changes translate into biologically significant effects—effects that have repercussions for the animal beyond the time of disturbance, effects on the animal's ability to engage in essential activities, and effects that have potential consequences at the population level.

The basic goal of marine mammal conservation is to prevent human activities from harming marine mammal populations. The threat from commercial whaling was obvious, but it is more difficult to estimate the population consequences of activities that have less immediately dramatic outcomes, such as those with indirect or small but persistent effects. The life histories and habitat of marine mammals compound the difficulties.

Marine mammals are long-lived and slow to mature. The young of many species are dependent for long periods. They are highly social, have behavioral plasticity, and have complex processes of behavioral development. Many of their behaviors occur underwater, where they are difficult to document, and that makes it particularly hard to estimate the effects of a short-term exposure as they ripple through the lifetime of an individual or as the effects on different individuals ripple through the population. Even extreme effects, including death, are not necessarily observed.

With the exception of the beaked whale strandings, connections between anthropogenic sound in the oceans and marine mammal deaths have not been documented. In the presence of clear evidence of lethal interactions between humans and marine mammals in association with fishing and vessel collisions (Clapham et al., 1999; Laist et al., 2001), the absence of such documentation has raised the question of the relative importance of sound in the spectrum of anthropogenic effects on marine mammal populations. Anthropogenic ocean noise is thought not to be a factor in any of the recent major declines in marine mammal populations, such as Steller sea lions (*Eumetopias jubatus*; NRC, 2003a), harbor seals (*Phoca vitulina*; Pitcher, 1990), fur seals (York, 1987), and Aleutian Island sea otters (*Enhydra lutris*; Doroff et al., 2003). No scientific studies have conclusively demonstrated a link between exposure to sound and adverse effects on a marine mammal population. These considerations have led to alternative assessments of the effects of sound on marine mammals. On the one hand, sound may represent only a second-order effect on the conservation of marine mammal populations; on the other hand, what we have observed so far may be only the first early warnings or "tip of the iceberg" with respect to sound and marine mammals.

HISTORY OF NATIONAL RESEARCH COUNCIL REPORTS

The National Research Council has produced three reports on the effects of noise on marine mammals, in 1994, 2000, and 2003. The primary goal of the first, *Low-Frequency Sound and Marine Mammals: Current Knowledge and Research Needs*, was to address the specific issues raised by the Heard Island Feasibility Test, which sought to "establish the limits of usable, long-range acoustic transmissions" (Munk et al., 1994). The feasibility test was preliminary to the ATOC experiment. The ATOC project proposed to measure the speed of sound across ocean basins as a way to monitor global climate change, and it required long-range transmissions of underwater sound regularly from several sites for decades. The 1994 report recommended research with respect to low-frequency (1- to 1,000-Hz) sound and marine mammals that was needed before a full deployment of ATOC. The report also noted that regulation of marine mammal research impeded exactly the type of research needed to determine if anthropogenic noise is detrimental to the animals. The report included an entire chapter on regulatory issues (NRC, 1994).

The Marine Mammal Protection Act (MMPA, 16 U.S.C. 1361-1401 et seq.) enacted in 1972 is the legal instrument of the US federal government for protection of marine mammals. The 1994 National Research Council report was concerned that the statutory term *harassment*, included in the MMPA but undefined in regulation, was "being interpreted through practice to include any action that results in an observable change in the behavior of a marine mammal" (Swartz and Hofman, 1991). The report pointed out (pg. 28) that

> As researchers develop more sophisticated methods for measuring the behavior and physiology of marine mammals in the field (e.g., via telemetry), it is likely that detectable reactions, however minor and brief, will be documented at lower and lower received levels of human-made sound. . . . In that case, subtle and brief reactions are likely to have no effect on the well-being of marine mammal individuals or populations.

The report recommended that legislative distinctions be made between different types of taking and that the regulatory agencies streamline the permitting process for activities that do not kill or capture marine mammals. Additional streamlining should be considered for nonlethal activities that have negligible effects. Agencies were encouraged to regulate within the context of total human impacts on marine mammals—including fisheries, shipping, the oil and gas industry, and research activities—and to expend their primary effort on activities with the greatest potential for harm.

The 2000 National Research Council report, *Marine Mammals and Low-frequency Sound: Progress Since 1994*, noted that the 1994 amendments to the MMPA addressed some of the issues raised in the 1994 report. The 1994 amendments introduced two levels of disturbance that are considered regulated takings—level A and level B harassment. Level A harassment is "any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild." Level B harassment is "any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering." However, the 2000 National Research Council report continued to emphasize the importance of a criterion for significance of disruption of behavior (pg. 68):

> It does not make sense to regulate minor changes in behavior having no adverse impact; rather regulations must focus on significant disruption of behaviors critical to survival and reproduction.

The report recommended a redefinition of level B harassment as any act that (pg. 69)

> has the potential to disturb a marine mammal or marine mammal stock in the wild by causing meaningful disruption of biologically significant activities, including but not limited to, migration, breeding, care of young, predator avoidance or defense, and feeding.

Since the report was issued, the term *biologically significant* has been used in discussions of the 2003-2004 reauthorization of the MMPA (House Report 108-464). The US National Marine Fisheries Service (now National Oceanic and Atmospheric Administration [NOAA] Fisheries) has used the term in decisions to grant incidental harassment authorizations, but scientific investigation and description of what would constitute "biologically significant" have not been pursued in a comprehensive manner.

The 2003 National Research Council report, *Ocean Noise and Marine Mammals*, attempted to quantify the world ocean-noise budget between 1 and 200,000 Hz with particular attention to habitats that are important to marine mammals (NRC, 2003b). The basic question it addressed was the overall impact of human-made sound on the marine environment. The somewhat unsatisfactory answer was that the overall impact is unknown but there is cause for concern. It was noted that total energy contribution is not the best currency to use in determining the potential impact of human-made sound on marine organisms. The report offered a number of recommendations; the overarching one was the need to understand better the characteristics of ocean noise, particularly from human-made noise, and its potential effects on marine life, especially effects that may have population consequences.

Thus, each of the three previous National Research Council reports has recommended research to resolve critical uncertainties about the effects of noise on marine mammals. All three highlighted the need for research in behavioral ecology, auditory physiology and anatomy, nonauditory effects of sound, effects of sound on prey of marine mammals, and development of new techniques for measuring the effects of sound on marine mammals. The 2003 report also recommended research on sources and modeling of ocean noise. Some of the recommendations have led to research that has greatly reduced the data gap. For example, the 1994 and 2000 reports recommended experiments to determine acoustic exposures that would lead to temporary shifts in the threshold of hearing in marine mammals. In the last decade, several laboratories have conducted such experiments (Kastak et al., 1999; Finneran et al., 2000, 2002; Schlundt et al., 2000; Nachtigall et al., 2003, 2004), and there is much less uncertainty in modeling the exposures that start to cause physiological effects on hearing in the seal and small-toothed whale species that have been tested. There has been partial progress on other recommendations. For example, the 1994 report recommended the development of tags to record physiological characteristics, behavior, location, and sound exposure. In the last decade, tags have been developed to record all the features recommended (Burgess, 2001; Johnson and Tyack, 2003) except physiological measures. For many of the other research recommendations research is being conducted, but progress has been slow enough to warrant the establishment of a targeted research program.

The 2000 and 2003 National Research Council reports recommended better coordination between federal regulatory agencies and science-funding agencies to develop a multidisciplinary research program that would judge the quality of proposals with peer review. There has been little progress on those programmatic recommendations, and the present committee reemphasizes that progress in critical research requires that the federal government develop and fund a dedicated multidisciplinary research program on the subjects in question.

CALL FOR A NEW NATIONAL RESEARCH COUNCIL STUDY

The recommendations of the 2000 National Research Council report have received great attention and been applied by regulators, legislators, and permit applicants to describe level B harassment under the MMPA. The vagaries associated with the term *biologically significant behaviors* and what constitutes "meaningful" disruption of those behaviors have been problematic. In light of the litigious and legislative environment of the issue of the disturbance of marine mammals, several federal agencies (including the Office of Naval Research, the National Science Foundation, the Minerals Management Service, and NOAA), working through the National Oceanographic Partnership Program, requested that the National

Research Council undertake a study to clarify the meaning of the term used in the 2000 report. Which possible effects have population consequences? If we don't know, how can we determine them? The agencies, recognizing that effects will be biologically significant at individual and population levels, requested guidance from the present committee in making those determinations. At the individual level, the biological significance of an effect must be judged by changes in the ability of an animal to grow, survive, and reproduce. The population effect involves the cumulative impact on all individuals affected. The committee's charge, developed with those considerations in mind is shown in Box 1-1.

After discussion of and deliberation on the task statement, the committee recognized that the definition of level B harassment proposed in the 2000 report introduced two kinds of biological significance: one, with respect to animal activities, stated directly, and the other implied in the "meaningful disturbance" of those activities. On reflection, it became clear that animals in the wild rarely spend substantial amounts of time engaging in activities that are not biologically significant. Even seemingly frivolous

BOX 1-1
Statement of Task

In its 2000 report, *Marine Mammals and Low-frequency Sound*, the National Research Council recommended that the Marine Mammal Protection Act definition of "Level B harassment should be limited to meaningful disruption of biologically significant activities that could affect demographically important variables such as reproduction and longevity." Recognizing that the term "biologically significant" is increasingly used in resource management and conservation plans, this study will further describe the scientific basis of the term in the context of marine mammal conservation and management related to ocean noise. Based on input from a scientific workshop, consideration of the relevant literature, and other sources, the committee will produce a brief report that reviews and characterizes the current scientific understanding of when animal behavior modifications induced by transient and non-transient ocean acoustic sources individually or cumulatively affect individuals in ways that have negative consequences for populations.

activities, such as play, can be biologically significant (Bekoff and Byers, 1998). Therefore, the primary concern should be with determining when human activity elicits behavioral or physiological responses in marine mammals that rise to the level of biological significance. Population consequences of behavioral change result from the accumulation of responses of individuals. In some cases, thousands of behavioral effects accumulated over years may be necessary for any population consequences; in other cases, a single instance of behavioral response may have the potential for population consequences.

FINDING: As opposed to the definition of biologically significant activities, whose disruption can constitute harassment, the crucial determination is of when behavioral or physiological responses result in deleterious effects on the individual animals and the population.

The statement of task incorporates two issues that had been concerns of earlier National Research Council reports. One is the difference between statistically significant and biologically significant changes in behavior. As more subtle behavioral changes become capable of being observed, it is inevitable that exposure to noise will result in statistically significant changes in one or more of the observed behaviors, but it is not equally certain that the changes will have any biological significance either for the individual or for the population.

The second issue is the linking of short-term behavioral changes to possible consequences at the population level. How does one determine whether an acoustic disturbance can, or does, result in a change in population structure, distribution, or, ultimately, survival? In the absence of any comprehensive model for relating acoustic disturbance to population response with due consideration of all the intermediary steps and processes, the committee developed a conceptual model that, when supplemented with data, would facilitate the recognition of population effects of acoustic disturbance. The model includes an indication of the current state of knowledge and was designed to allow sensitivity analysis that can focus, stimulate, and direct research.

To elaborate the model, identify deficiencies, and summarize current understanding, the committee held a focused public workshop (Appendix C). Workshop panel members were presented with the conceptual model, named the Population Consequences of Acoustic Disturbance (PCAD) model (Appendix D), described in Chapter 2, and asked to apply their expertise in such fields as epidemiology and population biology. Workshop participants discussed the PCAD model—they related it to existing models, identified weaknesses in it, provided an assessment of data available to achieve its objectives, and evaluated the probability of achieving a predictive model in the next decade, given the current understanding of the processes linking behavior to vital rates and given the missing, but required, data. Participants agreed that the model provided a good basis for encompassing the components of the problem, defining needed data, and identifying the research agenda for the next decade. The consensus of the participants, both in their presentations and in breakout groups, was that the model incorporated the necessary components to become a predictive model when sufficient data became available. Workshop discussions of a number of topics improved the information and depth of analysis incorporated in this report, such as the examples of allostasis and the comparison of capital with income pinniped breeders. The initial model did not include the assessments of current knowledge of either the major categories of responses or the transfer functions. Those functions were assigned by the committee after the input of the workshop participants.

This report is the culmination of the workshop presentations, the public dialogues that ensued, and the committee's deliberations. The participants in the workshop made it clear that current empirical data and theoretical knowledge are insufficient to accomplish all the goals of the committee. Therefore, this report offers recommendations intended to provide a roadmap for the development of a predictive model of the effects of ocean noise on marine mammal populations and presents suggestions for temporary measures for regulating the effects until a predictive model is developed and tested.

FINDING: A conceptual model can assist in the understanding of acoustic disturbance of marine mammals and possible effects on populations of them. However, the paucity of data prevents such a model from having a predictive role now.

2

Current State of Knowledge of Behavioral and Physiological Effects of Noise on Marine Mammals

BEHAVIORAL RESPONSES TO ACOUSTIC STIMULI

Various approaches have been used to study behavioral responses of marine mammals to acoustic exposure. Observational studies have been used to correlate distributional or behavioral effects on uncontrolled human activities. That approach is particularly suited to the large spatial or temporal scales over which there may be consistent variation in human activities. For example, Bryant et al. (1984) collated sighting data from surveys of gray whales in one of their breeding lagoons. They reported fewer gray whales sighted after a saltworks started dredging and shipping in the lagoon. Gray whales apparently abandoned the lagoon during this activity, and took several years to start using the lagoon again after the saltworks ceased operating. Although long-term abandonment of critical gray whale breeding habitat clearly reaches the threshold of biological significance, it has not been demonstrated that it impeded the recovery of the population. Morton and Symonds (2002) report a significant decline in sightings of killer whales during a 5-year period when acoustic-harassment devices were operated in an area of water about 10 km × 10 km in an archipelago. The acoustic-harassment devices have a source level of about 194 dB re 1 μPa at 1m and are designed to be loud enough to deter pinnipeds from breaking into fish farms to feed, but they have unintended consequences for inshore cetaceans. The exposures that caused an avoidance reaction in the killer whales are not known—a common problem in correlational studies when precise relationships between acoustic stimuli and behavioral responses are obscure.

Researchers have addressed concerns that marine mammals might avoid intense sounds. Some census studies have towed hydrophones through areas with commercial seismic surveys. Rankin (1999) and Norris, et al. (2000) found no association between the signal-to-noise ratio of seismic impulses from airgun arrays and sighting rates of cetaceans, but they caution that their analysis was so crude that it was unable to detect changes in distribution of less than 100 km. Their study exemplifies the critical point that a reported lack of an effect must carefully specify the statistical power of a study to detect specific effects. Other studies sighting marine mammals closer to sound sources have found avoidance at several hundred to thousands of meters (e.g., Goold, 1996). And some studies have shown no displacements. Ringed seals *(Phoca hispida)* near an artificial-island drilling site were monitored before and during development of the site. Although in-air and underwater sound was audible to the seals for up to 5 km, there was no change in their density in that area between breeding seasons before and breeding seasons after development began (Moulton et al., 2003).

The last few decades have seen the development of experiments designed to study the causal relationship between exposure to sound and behavior. As Tyack et al. (2004) discuss, these controlled-exposure experiments (CEEs) are similar to playback experiments that are commonly used to study animal communication. The primary difference is that CEEs carefully titrate the acoustic exposure required to elicit a specific behavioral reaction. In few studies have responses of marine mammals been related to levels of anthropogenic sounds. Playback of sounds associated with oil-industry activities indicated a clear relationship between the received-sound pressure level and the probability that migrating gray whales will deviate from their migration path. For continuous sounds, about 50% of the whales avoided exposure to about 120 dB rms re 1 μPa; for short impulses from airguns (about 0.01 sec every 10 sec), 50% avoidance occurred at about 170 dB re 1 μPa (Malme et al., 1983, 1984; Tyack, 1998; airgun levels are average pulse pressures). Tyack and Clark (1998) replicated the earlier experiments of Malme and colleagues by using Surveillance Towed Array Sensor System-Low Frequency Active (SURTASS-LFA) sonar sounds transmitted for 42 sec every 6 min and found that course deflection occurred when the received levels were about 140 dB rms re 1 μPa. Not only was there a steady increase in avoidance with increasing received level of each stimulus type, but there also was a clear pattern in which higher levels were required to achieve the same avoidance when signals were of shorter duration and lower duty cycle. Similar relationships between temporary threshold shift (TTS) and duration of the sound have been shown in laboratory studies (see below in the discussion of physiological effects).

Other CEEs have found a relationship between received level of sound and probability of some responses and less relationship for others. In a playback experiment involving the SURTASS-LFA sound and singing humpback whales *(Megaptera novaeangliae)*, Fristrup et al. (2003) analyzed 378 songs recorded before, during, and after playback. They found that the songs of the humpback whales were longer when the playback was louder (they could not determine received level at the whale). Miller et al. (2000) followed 16 singers during 18 of the same playbacks. During 18 playbacks, nine of the whales stopped singing. Of the nine, four stopped when they joined with another whale (a normal baseline behavior), so, there were five cessations of song potentially in response to the sonar (although whales stop singing without joining even under baseline conditions). The received levels measured next to the whales were 120-150 dB rms re 1 μPa, and there was no relationship between received level and the probability of cessation of singing. For six whales in which at least one complete song was recorded during the playback, the songs were an average of 29% longer. Miller et al. (2000) did not find a significant increase in song length with received playback level, probably because their study was less powerful than that of a larger sample analyzed in Fristrup et al. (2003). A similar CEE with responses of right whales to three 2-min stimuli, 60% duty cycles, and energy of 500-4,500 Hz showed no relation between probability or strength of response and received level, which was 133-148 dB rms (Nowacek et al., 2003), but this result is also limited by the small sample.

Both observational studies and CEEs demonstrate that behavioral context can have a substantial effect on relationships of acoustic dosage to behavioral response. For example, Tyack and Clark (1998) report that the avoidance reaction found when the SURTASS-LFA sound source was placed in the middle of the migration path apparently disappeared when the sound source was placed just offshore of the main migration path, even if the whales passed close to the source. On a larger scale, beluga whales in the Canadian high arctic show intense and prolonged reactions to the propulsion sounds of icebreakers (Cosens and Dueck, 1988; Finley et al., 1990), whereas beluga whales in Bristol Bay, Alaska, continued to feed when surrounded by fishing vessels and resisted dispersal even when purposely harassed by motorboats (Fish and Vania, 1971). This context specificity of behavioral reactions to sound raises questions about the ecological validity of extrapolating data from captive animals to the wild.

The behavioral responses of marine mammals to acoustic stimuli vary widely, depending on the species, the context, the properties of the stimuli, and prior exposure of the animals (Wartzok et al., 2004). Species variation in auditory processing is so important that a distinction should certainly be made between taxonomic groups that have widely different hearing and sensitivity frequencies. For example, pinnipeds have lower maximal frequency of hearing and maximal sensitivity of hearing than odontocetes (toothed whales). They typically have a high-frequency cutoff in their underwater hearing between 30 and 60 kHz, and maximal sensitivity of about 60 dB re 1 μPa, and odontocetes have best frequency of hearing between 80 and 150 kHz and maximum sensitivity between 40-50 dB. Therefore, odontocetes can hear over a wider frequency range and have keener hearing than pinnipeds, so they could potentially be affected by a wider variety of sounds. Little is known about the frequency range of hearing and sensitivity of some marine mammal taxa, such as baleen whales, but several attempts have been made to divide marine mammals into functional categories on the basis of hearing (e.g., Ketten, 1994).

As mentioned above, some of the variation in responses between species or individuals may stem from differences in audition. Not only do different species have different hearing capabilities but there is considerable variation in hearing among conspecifics. One of the most predictable patterns in mammals involves age-related hearing loss, which particularly affects high frequencies and is more common in males than females (Willott et al., 2001).

Auditory processing is less likely than behavior to differ between captive and wild animals, and captive data on behavioral reactions closely linked to audition may be relevant to other settings. For example, Schlundt et al. (2000) noted disturbance reactions of captive bottlenose dolphins *(Tursiops truncatus)* and beluga whales during TTS experiments. The behavioral reactions involved avoidance of the source, refusal of participation in the test, aggressive threats, or attacks on the equipment. Finneran and Schlundt (2004) showed that the probability of those reactions increased with increasing received level from 160 to 200 dB rms re 1 μPa at 1m except for low-frequency (400-Hz) stimuli near the low-frequency boundary of auditory sensitivity. The kinds of reactions observed and how they scale with intense exposures near the level that provoked TTS suggest that the signals were perceived as annoyingly loud.

Some of the variation in responses to sound may stem from experience. There are several well-known mechanisms by which an animal modifies its responses to a sound stimulus, depending upon reinforcement correlated with exposure. The response of animals to an innocuous stimulus often wanes after repeated exposure—a process called habituation. The National Research Council (NRC, 1993) recommended studies on habituation of marine mammals to repeated human-made sounds. In one of few experimental studies of habituation in marine mammals, Cox et al. (2001) showed that porpoises tended to avoid at a distance of 208 m upon initial exposure to a 10-kHz pinger with a source level of 132 dB peak to peak re 1 μPa at 1m. This avoidance distance dropped by 50% within 4 days, and sightings within 125 m equaled control values within 10-11 days. The pingers are used on nets to prevent porpoises from becoming entangled in them, so evaluations of their effectiveness must take habituation into account.

Kastelein et al. (1997) report that a captive harbor porpoise *(Phocoena phocoena)* avoided exposure to high-frequency pingers with source levels of 103-117 dB rms re 1 μPa at 1m and received levels of 78-90 dB rms re 1 μPa. When exposed to a source with a level of 158 dB rms re 1 μPa at 1m, the porpoise swam as far away as possible in the enclosure and made shallow rapid dives. Those results combine with the results of Cox et al. (2001) to suggest that porpoises react to sound at much lower levels than the captive delphinids studied by Finneran and Schlundt (2004). However, the context of the captive studies was quite different: the dolphins and belugas studied by Finneran and Schlundt were being rewarded for submitting to exposure to intense sounds, whereas the porpoise was not being rewarded for remaining in the sound field.

If an animal in captivity or the wild is conditioned to associate a sound with a food reward, it may become more tolerant of the sound and may become sensitized and use the sound as a cue for foraging. Several large-scale studies have shown that the distribution of feeding baleen whales correlates with prey but not with loud sonar or industrial activities (Croll et al., 2001); but the studies were unable to test for potentially more subtle effects on feeding, such as reduced prey capture per unit effort and reduced time engaged in feeding.

Some of the strongest reactions of marine mammals to human-generated noise may occur when the sound happens to match their general template for predator sounds. The risk-benefit relationship is very different for predator defense and foraging. An animal may lose a meal if it fails to recognize a foraging opportunity, but it may die if it fails to detect predators. Animals do not have the luxury of learning to detect predators through experience with them. Deecke et al. (2002) showed that harbor seals responded strongly to playbacks of the calls of mammal-eating killer whales and unfamiliar fish-eating killer whales but not to familiar calls of local fish-eating killer whales. That suggests that, like birds studied with visual models of predators (Schleidt, 1961a; 1961b), these animals inherit diffuse templates for predators. They initially respond to any stimulus similar to the predator template but learn through habituation to cease responding to harmless variants of the general predator image.

It would make sense for animals to show strong reactions to novel sounds that fit within the predator template, whatever the received level. Indeed, the behavioral reactions of belugas to ice breaker noise match the local Inuit description of their responses to killer whales, a dangerous predator. Some of those strong reactions to novel sounds, such as the responses of diving right whales to an artificial alarm stimulus as reported by Nowacek et al. (2003), might be expected to habituate if the stimuli are distinguishable from real predators and are not associated with aversive effects. In fact, the only right whale subject not to respond was the last of six whales tested, and it may have heard the stimulus up to five times before. Beluga whales that fled icebreaker noise at received levels of 94-105 dB rms re 1 μPa returned in 1-2 days to the area where received icebreaker noise was 120 dB rms re 1 μPa (Finley et al., 1990). In contrast, Kastak and Schusterman (1996) reported that a captive elephant seal not only did not habituate but was sensitized to a broadband pulsed stimulus somewhat similar to killer whale echolocation clicks even though nothing dangerous or aversive was associated with the noise.

The low sound levels that stimulate intense responses of Arctic beluga whales (Frost et al., 1984; LGL and Greeneridge, 1986; Cosens and Dueck, 1988) contrast sharply with the high levels required to evoke responses in captive beluga whales (Finneran and Schlundt, 2004). This difference highlights that there are likely to be several kinds of response, depending on whether the animal is captive and whether the noise resembles that of a known predator. Annoyance responses may require levels of sound well above levels that may stimulate strong antipredator responses. If animals in the wild hear a sound that matches their auditory template for a predator, they may avoid exposures to sound levels much lower than those required to elicit the disturbance responses observed by Finneran and Schlundt (2004). If learning can modify the predator template, as suggested by

Deecke et al. (2002), it is essential to conduct studies of behavioral responses of animals to human-made stimuli in habitats resembling those encountered by wild populations.

An important property of most anthropogenic sound is that high-intensity levels are typically confined to the immediate location of the sound source (an exception is high-intensity, low-frequency sound), so any effects caused by exposure to high levels are reduced as animals move away from the source. However, high-intensity low-frequency sound travels well enough underwater that animals can detect signals at ranges of tens to hundreds of kilometers from the source. If, as in the case of Arctic belugas hearing icebreaker noise, exposure to low received levels can still trigger an intense response, a few sources may affect a large fraction of a population.

Even in the absence of a strong response, low received levels of sound can affect a large fraction of a population if the sound results in a masking of normal stimuli. Marine mammals show exquisite adaptations to overcome masking, but they may not be effective in the presence of pervasive anthropogenic sounds (reviewed in NRC, 2003b; Wartzok et al., 2004).

PHYSIOLOGICAL RESPONSES TO ACOUSTIC STIMULI

Auditory Damage

Most discussions of physiological effects of noise have centered on the auditory system. Audition has evolved for sensitivity to sound, so it is likely to be the physiological system most sensitive to acoustic stimuli that are within the frequency range of hearing. When the mammalian auditory system is exposed to a high level of sounds for a specific duration, the hair cells in the cochlea begin to fatigue and do not immediately return to their normal shape. When the hair cells fatigue in that way, the animal's hearing becomes less sensitive. If the exposure is below some critical energy flux density limit, the hair cells will eventually return to their normal shape; the hearing loss will be temporary, and the effect is termed a *temporary threshold shift* in hearing sensitivity, or TTS. If the sound exposure exceeds a higher limit, the hair cells in the cochlea become permanently damaged and will eventually die; the hearing loss will be permanent, and the effect is termed a *permanent threshold shift* in sensitivity, or PTS. TTS and PTS limits vary among individuals in a population, so they need to be characterized statistically. A relationship between the TTS limit and the PTS limit has been determined for laboratory animals; the appropriateness of extrapolating of such a relationship to marine mammals is untested.

A major recommendation of the National Research Council 1994 report supported the development of TTS studies in marine mammals. Since then, TTS experiments have been conducted in two species of odontocetes (*Tursiops truncatus* and *Delphinapterus leucas*) with both behavioral and electrophysiological techniques (Finneran et al., 2000; Schlundt et al., 2000; Nachtigall et al., 2003, 2004) and three species of pinnipeds (*Phoca vitulina, Zalophus californianus,* and *Mirounga augustirostris*) with behavioral techniques (Kastak et al., 1999; Finneran et al., 2002). Those experiments were conducted at three centers for research on marine mammals that have facilities to hold their own animals: the Hawaii Institute of Marine Biology of the University of Hawaii, Long Marine Laboratory of the University of California, Santa Cruz, and the Space and Naval Warfare Systems Center (SPAWAR) of the US Navy in San Diego. The scientists at the Hawaii Institute of Marine Biology used continuous random noise with a bandwidth slightly greater than 1 octave as the fatiguing stimulus and both behavioral and electrophysiological techniques to measure TTS in the bottlenose dolphin. The fatiguing stimulus had a broadband received level of 179 dB rms re 1 μPa, which was about 99 dB above the animal's pure-tone threshold of 80 dB at the test-tone frequency of 7.5 kHz (Nachtigall et al., 2003). Exposure to 50 min of the fatiguing stimulus resulted in a TTS of 2-18 dB. Recovery from the TTS occurred within 20 minutes after the cessation of the fatiguing stimulus. More recent studies (Nachtigall et al., 2004) that used an auditory brainstem response showed a TTS of 5-8 dB in response to 30 minutes of a 160-dB rms re 1 μPa fatiguing stimulus. Although the intensity of the fatiguing stimulus fell rapidly above 11 kHz, the greatest TTS was shown at 16 kHz. This pattern of TTS being more prominent at a frequency above the frequency of the fatiguing stimulus matches results for humans (Ward, 1963). The recovery occurred at 1.5 dB per doubling time with complete recovery within 45 min. The 1.5 dB recovery per doubling time was also found for recovery from the more intense 179 dB fatiguing stimulus used in the earlier study (Nachtigall et al., 2003). Researchers at Long Marine Laboratory used continuous random noise of 1-octave bandwidth as the fatiguing stimulus and a behavioral technique to measure TTS in the harbor seal *(Phoca vitulina),* California sea lion *(Zalophus californianus),* and elephant seal *(Mirounga augustirostris).* They exposed the subjects to 20-22 min of the fatiguing stimulus and found that it only had to be 60-75 dB above the hearing threshold to induce a TTS of 4-5 dB for test signals at frequencies between 100 Hz and 2 kHz. Threshold measurements conducted 24 hours after the cessation of the fatiguing stimulus indicated complete recovery from the TTS (Kastak et al., 1999). Researchers at SPAWAR used impulse sounds from a seismic watergun as the fatiguing stimulus and a behavioral technique to measure the TTS (Finneran et al., 2002). The fatiguing stimulus had a variable duration of about 1 ms, peak pressure of 160 kPa, a sound pressure of 226 dB peak-to-peak re 1 μPa at 1m, and an energy flux density of 186 dB re 1 $\mu Pa^2 s$, which produced a TTS of 7 and 6 dB at 0.4 and 30 kHz respectively in beluga whales but not at the other tested frequency of 4 kHz. In dolphins, no TTS could be demonstrated at 0.4, 4 or 30 kHz in spite of raising the fatiguing stimulus to its maximum intensity of 228 dB (Finneran et al., 2002). Each of these experiments used different durations of fatiguing stimuli. When the sound pressure required to produce a TTS is plotted against the duration of the stimulus for all these experiments, the result is a line with a slope of -3 dB per doubling of stimulus duration, that is, a line showing that the TTS occurred at about an equal energy in all cases tested to date.

Changes in hearing threshold, even TTSs, have the potential to affect population vital rates through increased predation or decreased foraging sources of individual animals that experience a TTS as they use sound for these tasks. A TTS also has the potential to decrease the range over which socially significant communication takes place, for example, between competing males, between males and females during mating season, and between mothers and offspring. Unless a critical opportunity is available only during a narrow time window, the potential effects on vital rates are important only if exposures and any resulting TTS are prolonged. In spite of the importance of sound for marine mammals, there is considerable variability in hearing sensitivity within a species, and there is evidence of age-related hearing loss.

Nonauditory Effects of Sound

Resonance Effects

A marine mammal has many airspaces and gas-filled tissues that could theoretically be driven into resonance by impinging acoustic energy. The lungs, air-filled sinuses that include those of the middle ears, and in the intestines, where there can be small gas bubbles, are among the areas that may be susceptible to resonance induced by acoustic sources. However, there were no published measurements of resonance in a marine mammal until the work of Finneran (2003), who measured the resonance of the lungs of a bottlenose dolphin and a beluga whale. Before Finneran's work, most studies of acoustic damage in marine mammals concentrated on the effects of shock waves, including blast-related phenomena.

Finneran (2003) used a backscatter technique to measure the resonance of the lungs of a 280-kg bottlenose dolphin and a 540-kg beluga whale. He obtained resonance frequencies of 30 Hz for the larger white whale and 36 Hz for the bottlenose dolphin. However, the resonance was highly damped and far less intense than predicted by a free-standing bubble model. The lungs experience a symmetric expansion and contraction when ensonified. How intensely a structure resonates at its resonant frequency can be quantified, and is represented by *Q*. The higher the *Q*, the more resonant the structure. The *Q* values measured in marine mammals are low. The *Q* of the lungs of the beluga whale was found to be 2.5, and of the bottlenose dolphin 3.1. Those *Q* values suggest a broad resonance property that is highly damped. Apparently, the tissue and other mass surrounding the lungs dampen the susceptibility of the lungs and probably other structures to resonate intensely.

Although other gas-filled structures will resonate at different frequencies, the probable low *Q* values, as in Finneran's study, suggest that resonance of air spaces is not likely to lead to detrimental physiological effects on marine mammals. That was also the conclusion of a panel of experts convened by National Oceanic and Atmospheric Administration (NOAA) Fisheries (NOAA, 2002).

Rectified Diffusion

Rectified diffusion is a physical phenomenon that leads to the growth of microscopic bubble nuclei in the presence of high-intensity sound. It has been demonstrated only in laboratory preparations, but it is theoretically possible that exposure to high-intensity sound could enhance bubble growth in humans and marine mammals (Crum and Mao, 1996). Rectified diffusion might be a possible mechanism of nonauditory acoustic trauma in human divers and marine mammals, in that bubbles in tissue or blood can lead to injury or death. Calculations by Crum and Mao (1996) suggest that, given a modest degree of nitrogen (N_2) supersaturation of biological tissues (for example, between 100% and 200%), the growth of normally stabilized nuclei would be unlikely to occur at sound pressures below 190 dB rms re 1 μPa. However, at sound pressures above 210 dB, significant bubble growth could occur. As nitrogen supersaturation increases, the exposure threshold of activation should decrease, and the growth rate of bubbles should increase.

Houser et al. (2001) modeled the accumulation of N_2 in the muscle of diving cetaceans on the basis of dive profiles of deep-diving odontocetes and data on N_2 accumulation previously measured in the muscle of diving bottlenose dolphins (Ridgway and Howard, 1979). The model necessarily assumed that N_2 kinetics were the same between species and that lung collapse occurred at 70 m—a prediction made by Ridgway and Howard for bottlenose dolphins. The conclusions of the model were that slow deep-diving cetaceans (diving beyond the depth of lung collapse), which had few extended surface intervals, would accumulate the greatest amount of N_2 in their tissues while diving. The slower the dive in water shallower than lung collapse, the longer the time the animal experiences pressure that drives the accumulation of gas in the tissues; short surface intervals between deep dives would limit the time the animal has to clear accumulated N_2 from its body.

The magnitude of tissue N_2 supersaturation—and thus the possibility of rectified diffusion—depends on dive behavior as described above. Records of dive behavior of beaked whales—Cuvier's beaked whale (*Ziphius cavirostris*) and Blainville's beaked whale (*Mesoplodon densirostris*)—presented at a recent workshop (Marine Mammal Commission, 2004) indicate that these animals have long deep dives followed by a short surfacing and than a series of shallow dives primarily within the region in which gas exchange occurs in the lung. The short surfacings and the repeated "bounce" dives near the surface could lead to high tissue N_2 pressure and the possibility of bubble formation. Those are the predominant species of beaked whales that have stranded in association with naval sonar activity, although other beaked whale species have also been involved.

Evidence of deleterious bubble formation in diving cetaceans and the putative causative mechanisms (acoustically and behaviorally mediated) remain open to debate. Jepson et al. (2003) conducted necropsies of stranded cetaceans and reported on signs of bubble-related injury, but their interpretation has been challenged (Piantadosi and Thalmann, 2004). No experimental evidence has been collected on the feasibility of the putative mechanisms of bubble formation in breath-hold divers. More research is needed to understand the role of rectified diffusion in marine mammals, but our current understanding suggests that it would be relevant only for animals exposed to sound substantially above 180 dB re 1 μPa, which is already considered by regulators to be a threshold for risk of other forms of injury.

PROGRESS ON EARLIER NATIONAL RESEARCH COUNCIL RECOMMENDATIONS

Three previous National Research Council reports recommended research to resolve critical uncertainties about the effects of noise on marine mammals (1994, 2000, 2003b). All three highlight the need for research in behavioral ecology, auditory physiology and anatomy, nonauditory effects of sound, effects of sound on prey of marine mammals, and development of new techniques. The 2003 report also recommended research on sources and modeling of ocean noise. Some of the recommendations have led to research that has greatly reduced the data gap. For example, the 1994 and 2000 reports recommended experiments to determine acoustic exposures that would lead to temporary shifts in the threshold of hearing of marine mammals. In the last decade, several laboratories have succeeded in conducting the experiments; as a result, the uncertainty involved in modeling the noise exposures that start to cause physiological effects on hearing has been reduced.

Progress has also been made on the recommendation with respect to development of new technology. For example, the 1994 report recommended the development of tags to record physiology, behavior, location, and sound exposure. In the last decade, tags have been developed to record all but physiological characteristics (Johnson and Tyack, 2003).

For many of the other research recommendations, research is being conducted, but progress has been slow enough over the last decade to argue for the establishment of a targeted research program. The 2000 and 2003 reports recommended better coordination between federal regulatory agencies and science-funding agencies to develop a multidisciplinary research program. It was recommended that the research program operate like that of the National Science Foundation and the Office of Naval Research, issuing targeted requests for proposals and judging the quality of proposals with peer review. Although some progress has been made, it is worth reiterating that progress on critical research requires that the federal government develop and fund a dedicated research program.

3

How to Get from Acoustic Disturbance to Population Effects

The committee developed a conceptual model, named the Population Consequences of Acoustic Disturbance (PCAD) model as a framework to break the overwhelmingly difficult task of tracing acoustic stimuli to population effects into several manageable stages (Figure 3-1). The PCAD model was created as a first attempt to trace acoustic disturbance through the life history of a marine mammal and then to determine the consequences for the population. The model also serves as a framework for identifying existing data and data gaps. The model was distributed to workshop participants (Appendix D) before the workshop, discussed during the workshop, and, with the input of workshop participants, refined afterwards. The model involves five levels of variables that are related by four transfer functions. The first transfer function relates acoustic stimuli to behavioral responses. The second expresses behavioral disruption in terms of effects on critical life functions, such as feeding and breeding. The third integrates these functional outcomes of responses over daily and seasonal cycles, to link them to vital rates (see Figure 3-1) in life history. The fourth transfer function relates changes in the vital rates of individuals to population effects. Current data are insufficient to allow the PCAD model to serve as more than a conceptual model, so the listing of data at the first three levels—involving sound characteristics, behaviors, and life functions—is exemplary rather than all-inclusive. The relationship between vital rates and population effects is well defined, but the specification of relevant population effects involves policy decisions as well as scientific judgments.

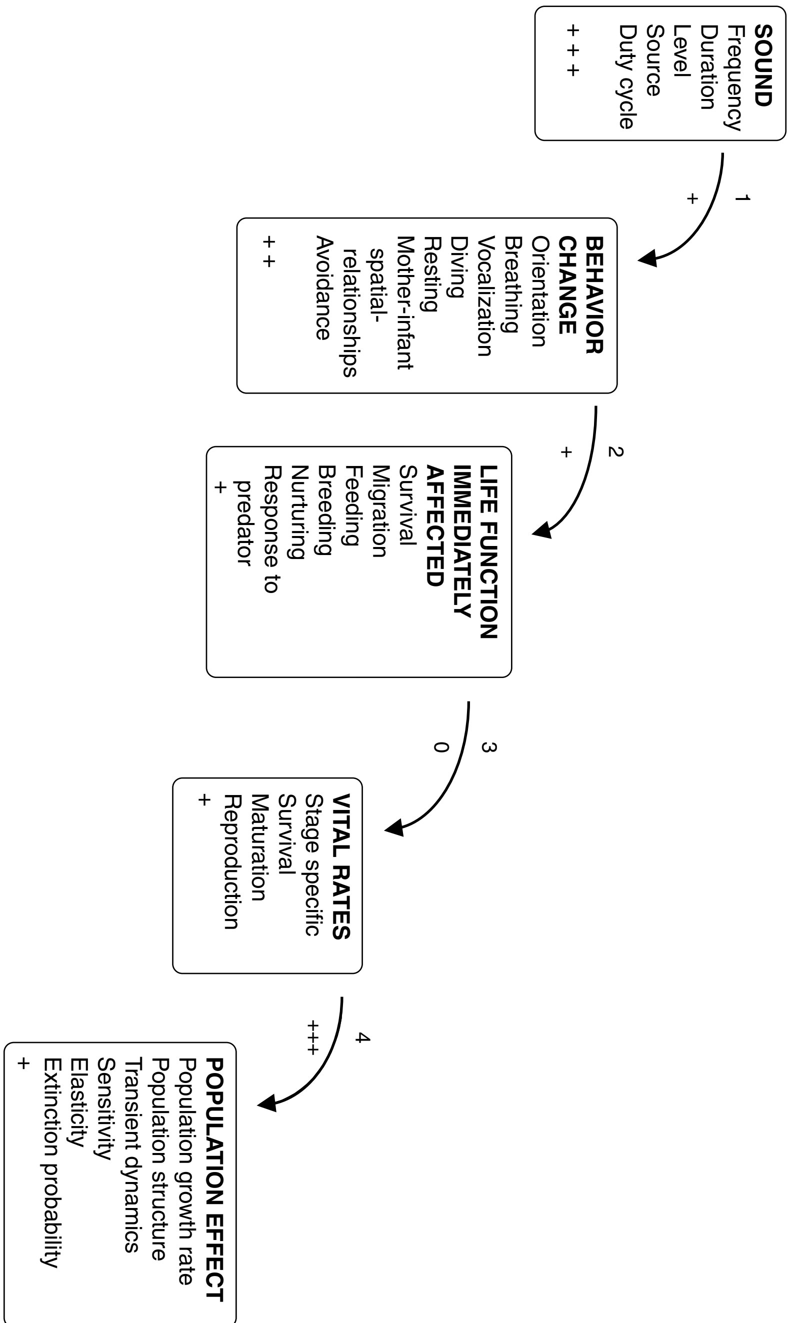
SOUND
Frequency
Duration
Level
Source
Duty cycle
+ + +
1
+
BEHAVIOR CHANGE
Orientation
Breathing
Vocalization
Diving
Resting
Mother-infant spatial-relationships
Avoidance
+ +
2
+
LIFE FUNCTION IMMEDIATELY AFFECTED
Survival
Migration
Feeding
Breeding
Nurturing
Response to predator
+
3
0
VITAL RATES
Stage specific
Survival
Maturation
Reproduction
+
4
+++
POPULATION EFFECT
Population growth rate
Population structure
Transient dynamics
Sensitivity
Elasticity
Extinction probability
+

FIGURE 3-1

The bottom entry in each data level presents an indicator of how readily available or easily obtainable the critical data are.

Although it would be unrealistic to expect to acquire the data necessary to run such a model for all species of marine mammals, it will be important to model a representative sample of pinnipeds, baleen whales, and odontocetes with different hearing ranges and hearing anatomies (Ketten, 1994). The recently discovered particular sensitivity of beaked whales to mid-frequency tactical sonar (D'Amico, 1998; Evans and England, 2001; Jepson et al., 2003) demonstrates the necessity for both care and comprehensiveness in the selection of representative species. The 2000 National Research Council report provided a reasonable selection of species, sound types, and behavioral responses that could be used in the PCAD model (Box 3-1).

FINDING: Prior National Research Council reports (NRC, 1994, 2000, 2003b) identified high-priority subjects of research. The model proposed here requires the data and understanding that will become available on the fulfillment of the earlier National Research Council high-priority research recommendations.

RECOMMENDATION 1: The high-priority research identified by the National Research Council (1994, 2000, 2003b) should be completed. That research is essential for the model proposed in this report.

FIGURE 3-1 The conceptual Population Consequences of Acoustic Disturbance model describes several stages required to relate acoustic disturbance to effects on a marine mammal population. Five groups of variables are of interest, and transfer functions specify the relationships between the variables listed, for example, how sounds of a given frequency affect the vocalization rate of a given species of marine mammal under specified conditions. Each box lists variables with observable features (sound, behavior change, life function affected, vital rates, and population effect). In most cases, the causal mechanisms of responses are not known. For example, survival is included as one of the life functions that could be affected to account for such situations as the beaked whale strandings, in which it is generally agreed that exposure to sound leads to death. The causal steps between reception of sound and death are by no means known or agreed on, but the result is clear. The "+" signs at the bottoms of the boxes indicate how well the variables can be measured. The indicators between boxes show how well the "black box" nature of the transfer functions is understood; these indicators scale from "+++" (well known and easily observed) to "0" (unknown).

BOX 3-1
High-Priority Research for Whales and Seals Recommended by National Research Council in 2000

To move beyond the requirement for extensive study of each sound source and each area in which it may be operated (NRC [2000] recommended that), a coordinated plan should be developed to explore how sound characteristics affect the responses of a representative set of marine mammal species in several biological contexts (e.g., feeding, migrating, and breeding). Research should be focused on studies of representative species using standard signal types, measuring a standard set of biological parameters, based on hearing type (Ketten, 1994), taxonomic group, and behavioral ecology (at least one species per group). This could allow the development of mathematical models that predict the levels and types of noise that pose a risk of injury or behavioral disturbance to marine mammals. Such models could be used to predict in multidimensional space where temporary threshold shift (TTS) is likely (a "TTS potential region") and TTS can be used as a threshold of potential risk of injury to the auditory systems. This coordinated plan can be used to set priorities for research required to determine measures of behavioral disruption for different species groups. Observations should include both trained (where possible) and wild animals (with attention to ecological validity). The results of such research could provide the necessary background for future environmental impact statements, regulations, and permitting processes.

Groupings of Species Estimated to Have Similar Sensitivity to Sound. Research and observations should be conducted on at least one species in each of the following seven groups:

1. Sperm whales (*Physeter macrocephalus*; not to include other physterids)
2. Baleen whales
3. Beaked whales
4. Pygmy (*Kogia breviceps*) and dwarf sperm whales (*Kogia sima*) and porpoises (high-frequency [greater than 100 kHz] narrowband sonar signals)

5. Delphinids (dolphins, white whales [*Delphinapterus leucas*], narwhals [*Monodon monoceros*], killer whales)
6. Phocids (true seals) and walruses
7. Otariids (eared seals and sea lions)

Signal Type. Standardized analytic signals should be developed for testing with individuals of the preceding seven species groups. These signals should emulate the signals used for human activities in the ocean, including impulse and continuous sources.

1. Impulse—airguns, explosions, sparkers, some types of sonar
2. Transient—frequency-modulated (low-frequency [LFA], other sonars, animal sounds), amplitude-modulated (animal sounds, ship passage), broadband (sonar)
3. Continuous—frequency-modulated, amplitude-modulated (drilling rigs), broadband (ship noise)

Biological Parameters to Measure. When testing representative species, several different biological parameters should be measured as a basis for future regulations and individual permitting decisions. These parameters include the following:

- Mortality
- TTS at signal frequency and other frequencies
- Injury—permanent threshold shifts
- Level B harassment
- Avoidance
- Masking (temporal and spectral)
- Absolute sensitivity
- Temporal integration function
- Nonauditory biological effects
- Biologically significant behaviors with the potential to change demographic parameters such as mortality and reproduction.

Modified from NRC (2000).

All the transfer functions in the PCAD model may vary depending on the season and the species, location, age, and sex of the animal. Other external factors may also modulate the responses and effects. For example, behavioral responses that would be insignificant in a normal year may become biologically significant during an El Niño year. Behavioral responses, on individual and population scales, may differ between a stable population near environmental carrying capacity and a severely depleted population. Those types of modulations are considered in the model in two primary, but not exclusive, categories: time and energy budgets and homeostasis and allostasis.

The first stages in the PCAD model are relatively clear. In general, the characteristics of the sounds can be measured accurately. In some cases, the behavioral responses of the animals can be measured as well. Although mechanistic models that relate sounds to behavior are unavailable, such an understanding is not essential for management use of this model if the behavioral changes can be measured and predicted.

Dose-response studies are a good way to quantify the first transfer function, relationship of sounds to behavioral responses. For marine mammals, data are available on only a few sounds and a few behaviors in a few species. Observational and correlational studies can provide trend data, and expert-opinion modeling can provide at least a "lookup" table to serve as a surrogate for this transfer function (Andelman et al., 2001). NOAA Fisheries has convened a panel of acoustic experts to survey the literature on mammalian hearing and the effects of noise and to draft noise-exposure criteria for five functional hearing groups of marine mammals (low-, middle-, and high-frequency cetaceans, pinnipeds in water, and pinnipeds in air) exposed to four sound types (single and multiple pulses and nonpulses). The criteria are based on individual sound-exposure events in which either the sound pressure (rms or peak) or the energy flux density exceeds one of two impact levels. The impact levels are tissue injury and behavioral disruption. Thus, the full matrix has 80 threshold criteria—the product of five animal groups, four sound types, two exposure metrics and two impact levels. The NOAA Fisheries panel has presented some portions of the criteria but has yet to complete a final draft. Some key elements of the criteria remain undetermined, particularly with regard to behavioral disturbance.

The second stage of the PCAD model attempts to evaluate how changes in behavior may affect life functions that are widely recognized as critical to population dynamics. With the exception of direct impact on life, the exact relationship of these functions to life-history characteristics is largely unknown. Furthermore, the impacts of sound on these functions through behavior will be difficult to measure.

Time-scale integration is important in identifying impacts and determining relationships between changes in behavior patterns and resulting changes in life functions. Because most marine mammals have a diurnal cycle of activities, integration of short-term functional consequences over a duration of at least 24 hours may be appropriate and could be studied by using behavioral observations or electronic tagging methods. In addition, however, most marine mammals also have strong seasonal variations in behavior and physiology. As more data are accumulated, daily functional consequences might be summed over each season in relation to the expected duration of exposure to the specific sound of interest to evaluate daily and seasonal effects in a particular species.

The final stages of the model relate changes in life functions in individuals to impacts at the population level. There are at least two components to these final stages. The first is the most difficult—relating changes in life functions to changes in vital rates of individuals. If the link from life functions to age-specific vital rates is known, changes in population dynamics can be explored by using demographic analyses. Current demographic theory provides the capability to deal with vital rates not only on the basis of age but also in terms of biologically defined stages that reflect developmental, behavioral, or physiological properties of individuals.

A critical question is what population consequences should be identified as significant. The measure of population performance must integrate survival and reproduction across the lifespan. It should have implications for recovery, persistence, and extinction of populations. The most thoroughly investigated index is the population growth rate (modified by such adjectives as potential, intrinsic, and asymptotic). Demographic theory provides tools that explicitly link changes in the life cycle to changes in population growth rate. That makes demographic models a powerful tool for placing bounds on likely effects, for exploring the quantitative implications of hypothesized interactions, and for synthesizing what is currently known. Establishing acceptable population effects is a management question that has already received a good deal of attention. One example used for protecting marine mammals involves setting the potential number of marine mammals that can be removed from the population without endangering the population. The management criteria of this Potential Biological Removal (PBR) model (Taylor et al., 2000; also see Chapter 4) are:

- Healthy populations will remain above the optimal sustainable population (OSP) numbers, as defined in the Marine Mammal Protection Act (MMPA), over the next 20 years.
- Recovering populations will reach OSP numbers after 100 years.
- The recovery of populations at high risk will not be delayed in reaching OSP numbers by more than 10% beyond the predicted time if there is no human-induced mortality.

The amount of information needed to map from sound to its population consequences is truly enormous. The PCAD diagram should be thought of not as the blueprint for an eventual universal model, but as a framework that clarifies where different kinds of information fit in and identifies processes that need study. Years of work will be required to accumulate data and develop models for the transfer functions between behavior and life functions, and between life functions and the vital rates. This report is essentially a status report and a roadmap for this critical long-term project of turning a conceptual model into a predictive model useful for science-based management of marine mammals and their exposure to sound. In the interim, techniques must be developed to use current information more effectively in making science-based management decisions. After discussion of the PCAD model, we propose (in Chapter 4) a means to achieve better management over a shorter timeline.

FINDING: A conceptual model, such as the PCAD model, is useful for clarifying the complex problem of acoustic-disturbance effects on marine mammal populations. Such a model can be used as a framework for identifying the cause-effect relationships necessary for determining consequences of disturbances. Data to complete this exercise are lacking and must be pursued from every available source.

RECOMMENDATION 2: A conceptual model, such as that described in this report, should be developed more fully to help to assess impacts of acoustic disturbance on marine mammal populations. Development of such a model will allow sensitivity analysis that can be used to focus, stimulate, and direct research on appropriate transfer functions.

In addition to research studies designed to evaluate reactions of marine mammals to noise, limited information is available from monitoring programs that are required of some activities that might "take" small numbers of marine mammals as defined in the MMPA. The incidental-harassment authorizations issued by the US government often contain the requirement for the operator to implement a program to monitor effects on marine mammals. For activities that produce intense noise, such as seismic surveys, the monitoring requirement often involves sighting animals from the vessel that is introducing the noise. Sighting surveys are also required by the United Kingdom and have been summarized in reports that identify avoidance reactions to seismic surveys (Stone, 2001, 2003). Few of those studies measured the acoustic stimulus from the activity as heard by the animal, and they typically scored easy-to-observe changes in behavior, such as respiration rate, time on the surface, duration of dive, change in swimming speed or direction, avoidance behavior, and aerial display. However, if those short-term measures are selected purely for ease of observation, it will often be difficult to link the responses to the functional categories described in the PCAD model, a link that is essential for extrapolating short-term measures to long-term effects that would alter some life function of an individual animal. Federal regulators for the last several decades have required monitoring programs instead of targeted research on the assumption that monitoring would detect developing problems. Monitoring programs, as implemented, have seldom provided the relevant data, suggesting that regulators and the regulated community should consider altering the balance of resources that they provide for monitoring versus research.

The impact of a behavioral reaction to sound depends on the number of animals affected in a population and on the duration and intensity of the reaction. The impact of avoidance reactions depends in the short term on the percentage of habitat reduction and on the ease with which animals can move to and use alternative habitat. Determining overall impact on the population requires estimation of

- The range of the impact of individual sources in time and space.
- The number of animals and the fraction of the population affected.
- The total impact of all sources deployed.
- The intensity of reaction of each animal.
- The duration of the impact on each animal.

The presence of anthropogenic sound sources could have minimal effects on a healthy population that can relocate with minimal effort or could be devastating to a small population that is living on the edge of its capabilities to survive where the sources affect its entire habitat (Box 3-2).

One of the few subjects of research that provide predictive models with connections from behavioral ecology through physiology to demography is how animals obtain and use energy. Behavioral ecologists have developed models to predict how animals maximize energy intake per unit of time as they forage (Stevens and Krebs, 1987). Physiologists and physiological ecologists have developed models to predict the baseline metabolic rates of animals and the metabolic costs of various activities. If a foraging animal takes in more energy than it uses for metabolism, it builds up an energy surplus that can be used for growth or reproduction. All large mammals have an initial period of sexual immaturity in which most surplus energy

BOX 3-2
Special Considerations for Endangered Populations

The effects of seismic surveys on western gray whales (*Eschrichtius robustus*) off Sakhalin Island, Russia, illustrate the potential for anthropogenic sound to have a severe impact on a marine mammal population. The western gray whale is critically endangered, numbering about 100, and depends on the northeastern Sakhalin Island feeding ground for most of its food intake. Weller et al. (2002) and Johnson (2002) report displacement of some whales during seismic surveys in 2001, and Johnson (2002) reports observations of gray whale behavior suggesting that they may have spent more time traveling and less time feeding during exposure to seismic signals, but aerial observations of feeding plumes were unable to detect any changes in feeding activity related to seismic activity. Disruption of feeding in preferred areas, especially in a small population in which many females (with and without calves) are already in poor condition and have long intervals between calf production (Brownell and Weller, 2002), could have major impacts on individual whales, their reproductive success, and even the survival of this critically endangered population (Weller et al., 2002). Observed changes in the distribution of individuals of this highly endangered population could be critical; deciphering their impact will require more detailed studies of prey distribution, foraging ecology, and energetics of these whales.

reserves go to growth. The timing of the transition to sexual maturity is affected by the need to have grown to a particular point and the need to have amassed sufficient energy reserves to support the energy cost of the transition. Once a female is mature, the timing between her ovulations, the probability of successfully carrying a fetus to term, and the interval between offspring are all affected adversely by lack of energy resources. Those characteristics are all used directly in demographic models to estimate the reproductive rate of the population. During periods of starvation, the probability of survival may be affected if the animal's metabolism exceeds energy intake for long periods. When foraging is not adequate, animals may abandon their young to conserve energy for their own survival. Limited energy resources may also make animals more vulnerable to other stressors (as discussed below in the section on allostasis). The various models that link foraging behavior, energy reserves, reproduction, and survival offer great promise for our proposed PCAD model, but more effort will be required to link the different submodels. The strength of research on energy budgets suggests that studies of effects of noise on foraging animals should focus on effects of disruption of time-energy budgets.

As noted earlier, repeated reports of unusual mass strandings of Blainville's and Cuvier's beaked whales show a correlation with naval maneuvers. The locations of whales with respect to the ships operating the sonars are unknown and cannot be reconstructed. However, the timing and spatial extent of the strandings suggest a possible risk of stranding for whales exposed to noise as low as 160 dB re 1 μPa. Current data on physiological or behavioral effects of well-studied marine mammals would not have suggested such a risk to poorly known beaked whales. The recent cases of the association of beaked whale strandings with naval sonar stimulated a review of prior records of beaked whale mass stranding events (Brownell et al., 2004; Taylor et al., 2004). This historical review indicated that mass strandings of beaked whales have occurred primarily subsequent to the introduction of mid-frequency tactical sonar in the early 1960s. However, caution must be exercised in these post hoc correlational studies. For example, when the radius of potential correlation extends to 500 km, as was the case with the strandings of *Z. cavirostris* and seismic in the Galapagos (Taylor et al., 2004), the potential for false positives increases proportionally. Therefore, there is a critical need for carefully designed and executed epidemiological studies to find potential problems as well as toxicological studies to evaluate precise dose-response relationships.

CURRENT DATA COLLECTION EFFORTS

In addition to basic research conducted primarily through universities and published in a host of peer-reviewed scientific journals, many data on marine mammals are gathered to fulfill regulatory requirements. For example, every permit application under the MMPA or the Endangered Species Act requires the applicant to provide a summary of the best available information on the status of the affected species or stock and on factors that affect the status. Permits for scientific research also contain many relevant data with respect to the habitat, behavior, physiology, or demography of the animals. A condition of many permits is the requirement to monitor the animals sighted, the time, location and oceanographic conditions of the observations, and the responses of the animals to the permitted activities. Federal agencies with responsibility for managing marine mammal populations conduct intramural research that often ends up as unpublished reports that contain valuable information. For example, NOAA Fisheries conducts surveys for assessing the status of marine mammal stocks. The agency publishes regular stock-assessment reports, but the sighting data would be extremely valuable for other purposes, such as predicting the species and number of animals that might be exposed to sound in a particular place and at a particular time.

Information from all these sources, with appropriate indicators of the sources, should be integrated into a common database. Peer-reviewed data and interpretation should be given the highest quality indicator. Other data sources should have appropriate quality indicators assigned. To facilitate the integration of data from many sources, federal agencies should establish standard data-reporting formats to be used in permit applications, permit reports, and research sponsored by other entities in fulfillment of permit requirements. Some federal support has been provided to begin the development of such integrated databases. Examples of such support are the Office of Naval Research Effects of Sound on the Marine Environment project and the Marine Resource Assessments by the Commander in Chiefs, U.S. Atlantic and Pacific Fleets.

FINDING: A wealth of data on marine mammals is collected in compliance with federal regulatory requirements. Such data are not collected in a manner that allows easy access or use beyond the original intent of their collection (such as permit issuance). A data-coordination effort could improve our knowledge of marine mammal distribution, behavior, and population size; improve and standardize data used for regulatory processes; and greatly reduce the effort required of applicants for permits or authorization.

RECOMMENDATION 3: To assist in the development of the conceptual model, a centralized database of marine mammal sightings and their responses to anthropogenic sound in the ocean should be developed and should include

- **Published peer-reviewed papers in the scientific literature.**
- **Government technical reports.**
- **Data submitted to NOAA Fisheries and the US Fish and Wildlife Service in permit applications.**
- **Data submitted by industry to the Minerals Management Service for regulating off-shore hydrocarbon exploration and production.**
- **All relevant data accumulated by all federal agencies in the course of their research and operational activities, including monitoring.**

To facilitate the integration of data from the various sources, federal agencies need to develop standardized data-reporting formats. Survey data should include locations where marine mammals were detected and the track lines when personnel were monitoring for marine mammals, regardless of whether any were sighted. All data entered into such an integrated database must be coded as to quality, and peer-reviewed data and interpretations should be rated highest.

DATA NEEDED TO DETERMINE PHYSIOLOGICAL RESPONSES TO ACOUSTIC STIMULI

Immediate behavioral responses are the easiest to observe, but the population consequences of sound will be modulated through physiological responses. The ear is the body structure most sensitive to acoustic input and is the site at which acoustic energy in the frequency range of hearing is most likely to have direct physiological effects. This report reiterates the recommendations of the 1994 and 2000 National Research Council reports to acquire more data on assessments of hearing characteristics such as absolute sensitivity, masking, temporary threshold shifts, and temporal integration, and on the evaluation of behavior during exposure. However, the long-term effects of noise exposure on individuals can be best determined through the physiological integration that occurs and can be observed as indicators of cumulative stress.

Physiological Stress Effects

Anthropogenic sound is a potential source of stress in marine mammals, and it has been shown to increase blood pressure and catecholamine and cortisol concentrations in humans (Evans et al., 1995; Evans et al., 2001; Ising and Kruppa, 2004). Biomedical research on stress has provided a theoretical framework that can help scientists to conceptualize and ultimately measure the cumulative impact of multiple stressors on individual animals (McEwen and Stellar, 1993; Seeman et al., 2001). Application of the concepts, theories, and techniques to marine mammals could accelerate our understanding of the physiological effects of noise and other stressors on them.

Historically, the term *stress* has been used to refer to several concepts, including noxious stimuli, the physiological and behavioral coping responses of organisms to noxious stimuli, and the pathological states that result when the coping responses can no longer restore the body to a normal condition. Several attempts have been made to provide a less ambiguous terminology. For example, Romero (2004) refers to the three concepts listed above as *stressors*, the *stress respon*se, and *chronic stress*, respectively, and this terminology is used productively in the physiological and behavioral literature. An alternative terminology, which we will consider in some detail because of its conceptual integration with energy budgets and life-history events, has been offered by McEwen and Wingfield (2003). It focuses on the concept of allostatic load, which was adapted from the cardiovascular field and was introduced for more broad application and developed by McEwen and colleagues (McEwen and Stellar, 1993).

McEwen and Wingfield (2003) propose four terms—*allostasis*, *allostatic state*, *allostatic load*, and *allostatic overload*, that can be considered in relation to the life cycle and energy budget of any species (Figure 3-2). Although energy is a convenient currency to consider for illustrative purposes, it could be replaced in Figure 3-2 by any other resource vital to survival, such as a particular vitamin or mineral. *Allostasis* refers to the physiological and behavioral mechanisms used by an organism to support homeostasis (the

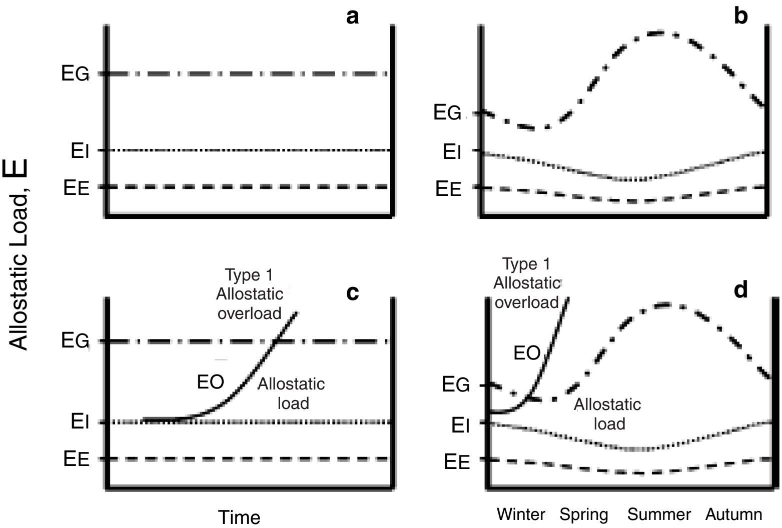

FIGURE 3-2 A framework for modeling energy requirements (E) of organisms during their life cycle. This energy requirement, E, includes all potential nutritional requirements, including energy itself. These separate and distinct requirements are represented more generally here for convenience, although essential components of nutrition could also be modeled separately. EE represents the energy required for basic homeostasis. EI represents the extra energy required for the organism to find, process, and assimilate food in ideal conditions. EG represents the amount of energy (in food) available in the environment (from Wingfield et al., 1998; Wingfield and Ramenofsky, 1999). (a) The three are represented as straight lines when environmental and physiological states do not vary over time. (b) The changes in the quantities have been adjusted to represent probable seasonal changes. EG would be expected to rise dramatically in spring and summer, when primary productivity is high, and then decline through autumn and winter, when primary productivity is low. In this scenario, EE would be lowest in summer, when ambient temperatures are highest. EI should be fairly constant (under ideal conditions) and should vary in parallel with EE. (c) EO represents additional costs incurred after a perturbation (such as a storm or anthropogenic disturbance) that increases costs above EE + EI. It represents the energy required to find food, process it, and assimilate nutrients in nonideal conditions. Allostatic load (see text) increases as EO persists. If EO exceeds EG, type 1 allostatic overload begins, resulting in an increase in plasma glucocorticosteroids. That usually triggers an emergency condition that results in altered physiology and behavior that reduces allostatic overload. (d) In more naturally fluctuating conditions, type 1 allostatic overload may occur first or more rapidly if a perturbation occurs during a season when the conditions are worse. If insults are permanent—such as those caused by even mild or moderate but persistent disturbances

caption continues

stability of the physiological systems that maintain life) in the face of normal and relatively predictable life-history events, such as migration, mating, rearing young, and seasonal changes in resource availability; unpredictable events, such as decreases in oceanic productivity and increases in human disturbance; and more permanent handicaps, such as injuries, parasites, and contaminant loads. Examples of allostatic responses are the physiological changes that occur in lactating female mammals (Bauman, 2000) and the changes in metabolism, muscle morphology, and behavior that occur in migrating birds (Kuenzel et al., 1999).

An "allostatic state" is a sustained imbalance in the physiological mediators, such as various hormones, that integrate behavioral and physiological responses to changing environmental conditions. An allostatic state can be maintained for some time if environmental resources are sufficient. However, the cumulative result of an organism's allostatic state is its "allostatic load." The usual allostatic load results from the organism's need to obtain enough food to survive plus any extra energy required for normal seasonal activities, such as migrating, molting, mating, and lactating. Animals can adapt to the extra demands within limits. However, if resources in the environment are insufficient (Figure 3-2d) or if other challenges—such as disease, human disturbance, or stressful social interactions—increase the allostatic load, the animal can no longer cope and will develop serious pathological conditions or die.

The concept of allostasis makes it clear that the effect of any given stressor will be contingent on multiple factors, including species, sex, nutritional and reproductive condition, and any other stressors currently affecting an animal. The closer an animal is to the condition of allostatic overload when subjected to an additional stressor, the more likely it is that

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FIGURE 3-2 caption continued

(e.g., Creel et al., 2002 for effects of snowmobile activity on wolves and elk), abnormally high densities of animals, increased pollutants (Porter et al., 1999), disadvantageous social status in some terrestrial species (Goymann and Wingfield, 2004; Sands and Creel, 2004), or individual differences in emotional or other vulnerable states (Sapolsky, 1994 for baboons; Cavigelli and McClintock, 2003 for rats)—overload will occur in most seasons and will be triggered readily even in seasons or conditions that are otherwise benign.
SOURCE: Adapted from McEwen and Wingfield, 2003.

the additional stressor will have a deleterious impact. That is, the effect of a stressor often depends heavily on the context in which it occurs. The importance of context has also been shown by laboratory experiments that demonstrate that uncontrollable and unpredictable stimuli cause a greater stress response than controllable and predictable stimuli. For example, when two rats are given similar electrical shocks but only one can press a lever that terminates the shock for both, the rat that can terminate the shock has a dramatically lower hormonal response to the shock than the one that has no control over the length of the shock (Weiss, 1968).

Consideration of energy needs can also provide clues to the conditions in which marine mammals may be most likely to suffer allostatic overload. The following account of marine mammal energetics follows the recent review by Boyd (2002), who built on earlier reviews for pinnipeds (Lavigne et al., 1982; Costa, 1991, 1993) and cetaceans (Lockyer, 1981). Different species have different energy requirements and appear to balance their energy budgets by developing body sizes and life histories that match the distribution and abundance of their food. As body size increases, the period over which an animal must balance its energy budget lengthens. For example, the great baleen whales probably balance their energy budget on a 1-year cycle. They typically migrate to high latitudes during the summer to feed on krill or other seasonally abundant resources and store enough energy in the form of blubber for them to be able to fast for the rest of the year and reproduce in warmer but less productive tropical waters. Smaller species, such as most of the odontocetes (dolphins and porpoises), must balance their energy budgets on much shorter periods—months to days. Thus, energy considerations suggest that sound disturbance could severely affect the energy budget of baleen whales if it displaced them from their feeding grounds for a substantial fraction of the feeding season but would be less likely to have a serious effect on energy needs if it occurred in other circumstances, such as during migration, and merely displaced them temporarily from their normal migratory path.

The diverse lactation strategies of female pinnipeds provide a particularly good illustration of the relationships between body size, energetics, and behavior. Lactating pinnipeds nourish their pups from a food supply that may be near or very distant from the rookeries where they give birth. If sufficient food is available near the birth site for mothers to balance their own energy budget and provide for the pups, mothers make foraging trips during lactation. That strategy is followed by most of the otariids (fur seals and sea lions), which are relatively small for marine mammals (Costa, 1993). Larger species, such as most phocids (true seals), can forage over larger areas and use more dispersed prey resources. They can feed on lower-quality prey and need greater rates of prey consumption, but they can use a patchier prey distribution. For example, elephant seals feed thousands of kilometers from the sites where they give birth and, like the baleen whales, store enough energy in the form of fat to be able to fast while lactating (Costa et al., 1986; Boness and Bowen, 1996). Phocids appear to switch during lactation from foraging to fasting at a body mass of about 100 kg; harbor seals (80-100 kg) forage during lactation whereas gray seals (*Halichoerus grypus*, 130-180 kg) fast (Costa, 1991; Boyd, 2002).

The reproductive success of small pinnipeds that make repeated short-distance foraging trips during lactation is severely affected if they are unable to acquire normal amounts of prey. Evidence of that is provided by El Niño events, which occur at irregular intervals that tend to range between 2 and 7 years and result in greatly decreased productivity in the eastern tropical Pacific and greatly reduce the survival of pinniped pups (Trillmich and Ono, 1991). For example, during the 1982 El Niño, pup production was normal, but none of the pups survived the first 5 months after birth. In 1983, pup production was only 11% of normal, but survival of the pups returned to normal rates (Trillmich and Dellinger, 1991). Thus, energy considerations suggest that small otariid species could be affected rather quickly by anthropogenic noise close to their rookeries if it interrupted normal foraging whereas larger species that were not foraging during lactation would be more likely to meet their and their pups' energy needs in the presence of a similar disturbance.

The physiological stress response is highly conserved and similar across vertebrate taxa (Wingfield and Romero, 2001). As an integrator of stresses, neuroendrocrinological responses include both direct and indirect effects of noise exposure. Physiological responses to stressors are initiated by activation of the hypothalamic-pituitary-adrenal axis, which results in the release of catecholamines and stress hormones, such as glucocorticoids, from the adrenal glands (McEwen, 2000). Because the extent of the stress response often correlates with the general health of an animal, measuring the response can serve as a general indicator of the current condition of an animal, reflecting its health, its energy allocation, and the effect of human disturbances on it. The promise of applying this approach in the field is illustrated by recent research on marine iguanas *(Amblyrhynchus cristatus)* in the Galapagos Islands (Romero and Wikelski, 2001, 2002). During El Niño years, iguanas had higher baseline corticosteroid concentrations during famines. Handling of the iguanas also resulted in higher stress-induced corticosteroid concentrations than in normal years. Stress-induced corticosteroid concentrations in animals were good predictors of whether they would survive an El Niño event (Romero and Wikelski, 2001). Measurement of corticosteroid stress responses also showed that apparently low levels of oil contamination caused a strong hormonal stress response in iguanas. That response accurately predicted higher mortality over the next year among iguanas on oil-contaminated islands than on uncontaminated islands (Romero and Wikelski, 2002). A growing body of literature on terrestrial mammals has demonstrated sensitivity of glucocorticoids to sudden natural social stressors (e.g., Alberts et al., 1992 for wild baboons), to persistent natural stressors (e.g., Sapolsky, 1994), and to anthropogenic stressors (e.g., Creel et al., 2002 for wolves and elk).

Glucocorticoids may be part of the mechanisms by which behavioral effects are translated into altered rates of reproduction and mortality, and in other instances they will at least be indicators if not major players in the cascade of effects leading from behavior to survival and reproduction. As indicated above, it will be feasible in some cases to obtain fairly convincing evidence of the behavior-demography relationships with or without the physiological links between the two; but in most others, our greatest power will come from documenting behavior-glucocorticoid relationships in some studies and glucocorticoid-survival or glucocorticoid-reproduction relationships in others, as suggested by a number of studies already cited. Examples of an emerging picture of behavior-demography or behavior-glucocorticoid relationships from one of the best-studied wild large mammal species have been found in baboons (Box 3-3).

Physiological indicators of body condition and of pregnancy can be obtained from serum. Serum sampling of glucorticoid concentrations can also be used to obtain a physiological stress measure if the sample can be obtained before the stress of capture and sampling changes hormone concentrations in the blood. The maximal allowable time from capture to blood sampling is 2-3 min for small birds or rodents and 10-15 min for large monkeys. Determining the time for various marine mammals will identify the extent to which this technique can be applied usefully, at least in situations where capture for blood sampling is feasible.

In most cases, capture of marine mammals for blood sampling will be impossible. Instead, techniques will need to be developed to allow unrestrained blood sampling. Hill (1986) developed a package that could be attached to a freely diving Weddell seal and could take blood samples on

BOX 3-3
Behavior, Physiology, and Demography in Baboons

In baboons, a number of behavioral differences have been associated with altered demographics. Reduced travel time to foraging sites leads to a net positive increase in energy balance (Muruthi et al., 1991) and presumably thereby to the observed decreased age of maturation (Altmann et al., 1993), doubling of reproduction (halving of interbirth interval), and increasing offspring survival (J. Altmann, Department of Ecology and Evolutionary Biology, Princeton University, Princeton, NJ, unpublished data, 2004; S.C. Alberts, Department of Biology, Duke University, Durham, NC, unpublished data, 2004) despite increased rates of aggression (Altmann and Muruthi, 1988). Daughters and sons of low-status females mature later (Altmann et al., 1988; Alberts and Altmann, 1995). Larger baboon social groups are associated with decreased reproductive rates of lower-status females (Altmann and Alberts, 2003). Infants of females that are more social have higher survival (Silk et al., 2003). Effects of chronic or sudden behavioral differences on stress hormones have also been demonstrated in baboon studies. Among baboon males, either social status or degree of sociality affects glucocorticoid concentrations (Sapolsky et al., 1997), as does social style or recent winning or losing of fights (Sapolsky, 1994). Sudden social disruption by immigration of an aggressive male leads to high glucocorticoids in both sexes and in the aggressive immigrant itself (Alberts et al., 1992). Despite that body of data, however, studies linking small chronic differences in glucocorticoids to vital rates in such a large mammal are only now possible and are being conducted thanks to the recent techniques in fecal steroid analysis.

a programmed schedule. More recently, sophisticated data logger tags have been attached to marine mammals to study their responses to anthropogenic sounds (Burgess, 2001; Johnson and Tyack, 2003). Data logging packages could be modified to incorporate blood sampling during controlled-exposure experiments (CEEs). Initial studies would likely need to be conducted on Weddell seals constrained to returning to an isolated hole to breathe. Eventually, the packages would benefit from the ability to take blood samples on a controlled basis and stabilize hormones for later analysis or to conduct "on-board" blood-chemistry analysis to record responses of animals in situations less unusual than that of the Weddell seal.

Totally noninvasive, hands-off techniques of sampling glucocorticoids and other steroid hormone metabolites (such as estrogens, testosterone metabolites, and progestins) through collection of feces or urine are increasingly used for terrestrial mammals in situations or with species that make capture or any disruption to behavior intolerable (e.g., Wasser et al., 2000). The feasibility of feces collection from some marine mammals in the ocean has been demonstrated (Rolland et al., 2004); validation and calibration of the assays should have high priority (Buchanan and Goldsmith, 2004; Hunt et al., 2004). Preliminary studies measuring glucocorticoids in hair samples and up-regulation of stress-induced proteins in skin samples merit further development. Concentrations of fecal progestins are increasingly used in research and conservation for assessing pregnancy in terrestrial mammals. Application to marine mammals to evaluate pregnancy rates and fetal or early infant loss may be relatively straightforward (Larson et al., 2003) when the requisite samples can be obtained.

FINDING: Measurements of glucocorticoids and other steroid hormone metabolites in terrestrial vertebrates have proved to be good indicators of pregnancy, allostatic overload, and mortality risk posed by current and new stressors.

FINDING: Continued development of more-sophisticated data logger tags is necessary to advance the study of marine mammal responses to anthropogenic sounds. Data logging packages should be modified to incorporate blood sampling during controlled-exposure experiments (CEEs).

RECOMMENDATION 4: The use of glucocorticoid and other serum hormone concentrations to assess stress should be developed, validated, and calibrated for various marine mammal species and age-sex classes and conditions. Dose-Response curves for those indicators as a function of sound characteristics need to be established. Development of a sampling package that could take blood samples on a controlled basis and stabilize hormones for later analysis or process samples "on-board" for corticosteroids at various stages of a CEE would be invaluable for determining the stress that the sound is producing. The use of fecal sampling to measure condition or stress needs

to be investigated further and developed. Research efforts should seek to determine whether reliable long-term stress indicators exist and, if so, whether they can be used to differentiate between noise-induced stress and other sources of stress in representative marine mammal species (this recommendation was also made in NRC, 2003b).

Toxicology

The concept of allostasis provides a framework for understanding how anthropogenic noises that at first appear insignificant could, with repeated exposure or in combination with other stressors, compromise an animal's survival and reproduction. Recent research in toxicology has provided cautionary examples of how the combined actions of apparently safe individual factors can have serious unforeseen consequences. For example, a mixture of several agrochemicals at concentrations commonly found in groundwater across the United States affected immune, endocrine, and nervous system function in wild deer mice (*Peromyscus maniculatus*) and outbred white mice when consumed for 14-103 days (Porter et al., 1999). In this 5-year study with a full factorial design, numerous deleterious changes occurred in response to mixtures of aldicarb (an insecticide), atrazine (a herbicide), and nitrate (a fertilizer) at low concentrations, but the changes were rarely seen when the compounds were tested individually at the same concentrations. In another study, a commercial herbicide containing a mixture of 2,4-dichlorophenoxyacetic acid (2,4-D), mecoprop, dicamba, and several inert ingredients led to a U-shaped dose-response curve for litter size in mice; the lowest dosages of the mixture caused the greatest decrease in the number of live pups born (Cavieres et al., 2002). Such studies demonstrate that multiple stressors can interact in complex and unforeseen ways to produce adverse effects on living organisms.

DATA NEEDED TO DESCRIBE MARINE MAMMAL POPULATIONS

To understand the behavioral effect that a sound may have in a given place and at a given time, it is necessary to be able to answer the following questions:

- What species are present?
- What is their distribution?
- What are their grouping patterns?
- What activities are they engaged in?
- How is each activity disrupted by sound?

NOAA Fisheries has collected and analyzed data on sightings of marine mammals to assess the status of different populations, and extensive sighting data are available from other sources, but the data are not available in a form that allows the prediction of the number of animals likely to be exposed to a sound in a given place and at a given time. Grouping patterns are important because if animals live in groups an average density will not yield a correct probability of the number of animals exposed.

Even fewer data are available on how marine mammals use different areas. That data gap could be addressed by completing basic behavioral ecological studies of marine mammals in the wild. To understand the biological significance of behavioral disruption, a greatly accelerated program is needed for studying the behavior and ecology of marine mammals in the wild, with a focus on how variation in behavior may affect probabilities of survival, growth, and reproduction in different ecological settings. The first recommendations for research in the 1994 and 2000 National Research Council reports were to study the behavior of marine mammals in the wild. Ten years after the 1994 report, a major increase in support of research to fill this critical data gap is still needed. The urgency of a research program in this field is highlighted by the PCAD model.

INDIVIDUALS TO POPULATIONS: USING MODELS TO IMPROVE UNDERSTANDING

In the PCAD model, there are at least some data that link sounds to behavioral responses of individuals. The connection between individuals and the population is much more speculative. There are good reasons for this lack of data. Most effects on life functions are separated in time and space from the immediate behavioral responses to sounds. Thus, if later observations identified life-function activities outside the normal range, it would be difficult to relate them to prior exposure to sound. Furthermore, our current understanding of the behaviors associated with most life functions is incomplete. For example, we do not yet fully understand normal ranges of the behaviors, so effects may not be detected even if they are observable. As noted previously, there is almost no understanding of how changes in any of the life functions lead to changes in vital rates.

The only way to build a bridge from the individual to a population is modeling of some kind. No single model will serve the purpose, but a number of modeling exercises could help to integrate what is known tactically (in the short term) and to structure strategic research in the longer term. We consider here the types of modeling that might prove helpful and the expectations for each.

Uses of Models: Prediction and Exploration

The use of models for prediction is most successful when a well-established understanding of the processes and a good database for parameterizing the model exist. With respect to linking individual to population effects in marine mammals, both understanding and data are lacking (Figure 3-3, Area 4). Predictive modeling to determine the population effects of noise on marine mammals is therefore not now an option.

The determination of an appropriate modeling technique depends on the information and understanding available (Starfield and Bleloch, 1991). A schematic representation can be used to describe possible approaches (Figure 3-3). Area 1 is the region of good data but little understanding; statistical tools are applicable and can be used to perform an exploratory data analysis (sensu Tukey, 1977) to search for patterns and relationships. Area 3 is the region of good data and good understanding where predictive modeling has the best chance of success; well-established paradigms and modeling approaches can be used with confidence and are backed by experience and theory.

If either data quantity or quality is poor, a modeler is restricted to Areas 2 and 4, referred to as “data-limited.” In Area 2, there is good understanding of the processes and structure of the problem; in Area 4, that understanding is weak. Marine mammal data are still sparse, so this report is concerned mainly with Areas 2 and 4. Issues in these two areas present the modeler with two daunting challenges:

- Despite the lack of data and understanding, a management or policy decision must be made. How can modelers help to make the best scientific decisions under these circumstances?

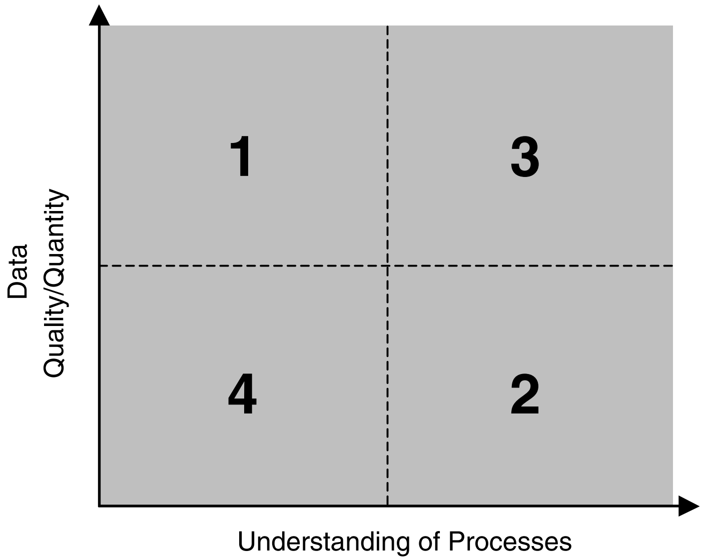

FIGURE 3-3 Classification of modeling problems.
SOURCE: Holling, 1978.

- How can models be used to exploit available data to improve understanding and, in turn, identify data that are critically needed? In other words, how do we progress from Area 4 toward Area 3?

Scientists and modelers are often uncomfortable dealing with these issues. Some believe that modeling should be confined to Area 3; others push ahead and try to use predictive models in an area where prediction is, to say the least, risky. Starfield and Bleloch (1991) suggest that Areas 2 and 4 require a different paradigm in which models are used tentatively to explore alternative hypotheses, speculate on possible outcomes given whatever data are available, and then cautiously reach some conclusions—even if they are only conclusions about future research needs. The way that they propose using models in Areas 2 and 4 is philosophically akin to Tukey's exploratory data analysis; that is why the term *exploratory modeling* is used.

Exploratory models can be used as tools for synthesizing what is known, explaining what may be happening, or perhaps guiding research or management. In all cases, if modeling is to serve a useful function, it is essential that the purpose or objective of each modeling exercise is clearly defined, the model is focused ruthlessly on the objectives, and all involved with the modeling exercises have a pragmatic appreciation of the power (or lack thereof) of whatever modeling paradigm is developed. These are some of the objectives for a suite of modeling exercises:

- *Objective 1: To bound the problem or look for significant thresholds.* In the introduction, it was stated that it is not clear whether noise has a second-order effect on populations or whether what has so far been observed is only the tip of the iceberg. Models could help to categorize the likely effect of specified noise doses on different populations. That type of modeling exercise would be useful even if it produced the limited result that "Dose X is unlikely to have a measurable effect on a population with these characteristics, but it could have a measurable effect on a population with those characteristics."
- *Objective 2: To speculate on the likely outcome of hypothesized interactions.* The objective is to take a word model (such as "disruptions of courtship in species X will have a significant impact on the recovery of the species") and tease out the implications quantitatively. The modeling would perforce be speculative, but there is value to exploring explicitly which assumptions and which sets of parameter values support the hypothesis. To quote Samuel Johnson, "That, sir, is the good of counting. It brings everything to a certainty which before floated in the mind indefinitely."
- *Objective 3: To synthesize and organize what is currently known.* For example, we know that responses can be situation-specific. It has already been noted that the responses of migrating gray whales depend on whether a low-frequency active source is in the migratory path or a few kilometers seaward of the migratory path even though the received levels were similar (Tyack and Clark, 2000) and that the responses of beluga whales in the high arctic to the initial seasonal exposure to an icebreaker are stronger and more prolonged (Cosens and Dueck, 1988; Finley et al., 1990) than the responses of beluga in the same region to the icebreaker a few days later (Finley et al., 1990) and the responses of Bristol Bay, Alaska, beluga to

direct harassment attempts (Fish and Vania, 1971). It is likely that more is known than appears to be known—synthesis will produce more than the sum of the parts. There are three related objectives:

(1) To focus the attention of disciplinary scientists on how their knowledge and data can be combined or otherwise used to address the problem.
(2) To identify gaps in data and knowledge and explore what one minimally needs to do to fill the gaps.
(3) To provide guidelines for data collection and monitoring.

- *Objective 4: To develop a conceptual framework for management guidelines.* Models can be used to organize and improve management guidelines, such as described for the Potential Biological Removal management regime described in Chapter 4.

A number of alternative modeling paradigms and constructs could fit with some of those objectives. For example, the age-structured demographic models (Caswell, 1989) usually used for predictive modeling could be used in an exploratory way to help to bound the problem and establish thresholds for different species. It is difficult to be specific about suitable paradigms or the design of a model until the precise objectives of an exploratory modeling exercise are spelled out, but two additional potential approaches are offered: individual-based models (IBMs) and categorical or qualitative models. In the next sections of this report we describe three modeling approaches and two additional tools that might prove helpful.

Demographic Models

The most well-developed and widely used approach to population modeling is that of age-structured demographic analysis. A demographic model is one that categorizes individuals into groups based on biological characteristics relevant to their survival and reproduction. In classical demography those groups were based on age (and implicitly on sex), but it is now known that other criteria, such as maturity, reproductive status, physiological condition, and spatial location may be more important (e.g., Caswell, 2001). Stage-structured models are most commonly expressed as population projection matrices, which may include environmental stochasticity, demographic stochasticity, density-dependence, and spatial structure (Caswell, 2001).

Demographic models can be analyzed to obtain measures of population growth and structure, probabilities of extinction or quasi-extinction, and other measures of population performance. They employ a well-developed perturbation theory that permits calculation of the effect of changes in the vital rates on those measures of performance; this makes them particularly suitable for the exploration of thresholds and the effects of interactions. Matrix population models have a well-developed connection with statistical methods for parameter estimation, especially from observations of known individuals (e.g., Nichols et al., 1992; Fujiwara and Caswell, 2001, 2002a,b; Caswell and Fujiwara, 2004). These methods can incorporate measurements of individual animal condition into estimates of the vital rates. Recent research has explored Bayesian methods for parameter estimation in these models (Gross et al., 2002); such methods are particularly suitable for analysis of uncertainty.

Matrix models have been used for demographic analysis of killer whales (Brault and Caswell, 1993), humpback whales (Barlow and Clapham, 1997), right whales (Fujiwara and Caswell, 2001; Fujiwara, 2002), and harbor porpoises (Caswell et al., 1998) as well as various species of seals (e.g., Heide-Jorgensen et al., 1992; York, 1994; Kokko et al., 1997; Lalas and Bradshaw, 2003).

Although demographic models could be used to make predictions, their most common use is to explore the consequences of various biological processes in the face of unknown data. In two cases, the California condor (Mertz, 1971) and the Everglades kite (Nichols et al., 1980), only the most fragmentary data were available—both studies used demographic models to place bounds on population growth, to speculate on the outcome of hypothesized interactions, and to synthesize sparse data. More recent examples of exploratory use of demographic models include the exploration of management strategies for sea turtles (Crouse et al., 1987), the exploration of bycatch effects in harbor porpoise (Caswell et al., 1998), and exploration of research priorities for the sooty shearwater (Hunter et al., 2000).

Individual-Based Models

In an Individual-Based Model (IBM), the computer program is designed to simulate virtual individuals in a population, often from birth to death. Each individual carries a set of attributes or markers that describe the state of the individual. They can include demographic factors, such as age and sex; energy factors, such as weight, stomach fullness, and diet composition; location descriptors, such as latitude and longitude; and behavioral descriptors, such as reproductive status, dive intensity, and dominance role. Such programs as Tagging of Pacific Pelagics (Block et al., 2003) provide data on movement patterns in relation to oceanographic features and seasonal patterns of movement essential for constructing a valid IBM for these species. IBMs have been constructed for species in a variety of habitats (Grimm, 1999).

For example, an IBM has been designed to compare the effects of alternative trophy-hunting strategies (Whitman et al., 2004). It describes each male lion (at any time step) in terms of his age, social status (cub, nomad, or pride lion), associates (like-aged cubs, fellow nomads in a nomadic group, and fellow males in a pride coalition), and spatial position (which pride a cub is born into, which territories a pride coalition controls and patrols, and which territories a nomadic group is temporarily visiting). Those attributes enable one to simulate such processes as competition between neighboring pride males, territorial battles between resident pride males and visiting nomads, and infanticide when pride coalitions are replaced—all essential to an understanding of how trophy hunting might affect the size and structure of a lion population. Some other examples are the modeling of deer and Florida panther (*Puma concolor coryi*) populations in the Florida Everglades (Abbott et al., 1997) and of walleye pollock (*Theragra chalcogramma*) in the western Gulf of Alaska (Hermann et al., 2001).

IBMs can be used for purposes similar to those of structured demographic models and can also directly address questions about the interaction between, for example, behavior of animals in relation to a source and the resulting acoustic exposure, behavior and reproduction, or behavior and growth. They offer a direct venue for considering the effects of noise on marine mammal individuals and populations. They can accommodate the kinds of data that are now becoming available on the relationships between behavior and acoustic exposure in a direct and comprehensible fashion. For example, the Acoustic Integration Model (AIM; Frankel et al., 2002) models the location and dive behavior of simulated marine mammals swimming near a modeled acoustic source. An acoustic-propagation model is used to predict the exposure of the simulated animals and can program different response strategies of the animals for the simulated source. It has been used to predict the exposure of animals with different response patterns to sources with different modes of operation, monitoring, and mitigation; and it can help in selecting alternatives that minimize effects on marine mammals while maximizing operational effectiveness of the source.

Categorical or Qualitative Models

The links or transfer functions between changes in the behavior of individuals, effects on life functions, and effects on vital rates (survival and reproduction) of a population in the conceptual model (Figure 3-1) have been identified as ones on which there is little information. However, some progress might be made by combining whatever is known with an understanding of the behaviors and pressure points in different species to derive a qualitative ranking of the strength of a link. An example of behaviors and pressure points would be a marine mammal with an "income" breeding strategy (Costa, 1993) of intensively nursing newborn pups in bouts separated by extensive time at sea to replenish reserves. It can be argued that a reduction in the feeding success of mothers during that period will have a more severe effect on pup survival than an equivalent reduction in feeding success in a capital breeder (an animal that relies on stored energy to survive the breeding season).

A categorical or qualitative model would characterize effects in such terms as low, moderate, and severe. Such a model may separate the consequences of an effect from the probability that it will occur. It could be developed with a combination of available information on marine mammals, information on comparable nonmarine mammals selected on the basis of life-history scaling or body-size scaling, first principles, and expert opinion (Morgan and Henrion, 1990; Goodwin and Wright, 1991; Meyer and Booker, 1991; Anderson, 1998; Andelman et al., 2001).

The Scientific Committee on Antarctic Research (SCAR, 2004) created a series of risk-assessment matrices for different acoustic sources in Antarctic waters. The cells of a likelihood-consequences matrix indicated whether there was a potential risk to an individual or the population. One conclusion of this analysis was that the risks associated with the use of most scientific acoustic equipment in the Antarctic were less than or comparable with the risk associated simply with the passage of the research ship through Antarctic waters.

Categorical or qualitative models might serve two purposes: to create a structure for encouraging biologists to make the best determinations they can and to explore the feasibility of developing tactical management strategies akin to the PBR model (see Chapter 4). Essential components of such a model would be estimates of the reliability of every categorization in the model and explanations of how each categorization was reached. The models would provide a structure for further refinement and, like the proposed IBM and demographic modeling exercises, help to identify gaps in knowledge. The key point to make is that modeling exercises like this can lead to robust management approaches, as the PBR model demonstrates, even when knowledge is incomplete.

Expert Opinion

Data on many links in the chain from acoustic stimuli to population effects on marine mammal populations are sparse or lacking. Therefore, regulators such as NOAA Fisheries and the US Fish and Wildlife Service (FWS) may often find it necessary to rely on expert opinion regarding the probable effects of specific activities until more data accumulate. Although the use of expert opinion does not necessarily produce an accurate result (experts can be wrong, especially when data are lacking), it does provide a structured, well-documented basis for decision-making that often withstands legal scrutiny. Precedents for the use of expert opinion to evaluate risk in a conservation context are provided by the US Department of Agriculture Forest Service's extensive reliance on expert opinion for population-viability assessments under the National Forest Management Act (Andelman et al., 2001) and FWS's increasing use of expert opinion for making listing decisions under the Endangered Species Act (ESA; J. Cochrane, US Fish and Wildlife Service, personal communication, 2004). Because eliciting and using expert opinion are complex tasks beset with pitfalls for the inexperienced, any use of expert opinion should follow established procedures detailed in the substantial scientific literature on the subject (Morgan and Henrion, 1990; Goodwin and Wright, 1991; Meyer and Booker, 1991; Anderson, 1998; Andelman et al., 2001) to avoid bias and increase credibility.

Risk Assessment

Evaluating the effects of noise on marine mammal populations is a problem in risk assessment. Previous National Research Council reports have considered the general process of risk assessment by the federal government (NRC, 1983) and risk assessment in relation to contaminants and human health (NRC, 1993). Uncertainty is always a prominent feature of risk assessment, and uncertainty regarding the probable effects of human activities on marine mammals is not limited to the effects of noise but rather is a pervasive problem, which can be addressed using population models (Caswell et al., 1998; Ralls and Taylor, 2000).

Risk assessment can be combined with decision analysis to make management decisions in the face of uncertainty (Harwood, 2000, 2002). The general approach is discussed in detail with respect to making decisions under the ESA in an earlier Research Council report (NRC, 1995). There are two main categories of errors in judging the effects of human activities on natural resources: we may conclude that a risk is great when it is not, which leads to overprotection and unnecessary economic loss, or we may conclude that a risk is small when it is not, which leads to underprotection and avoidable loss of a valued resource. It is impossible to minimize simultaneously the probability of making those two types of errors, and common statistical practices of hypothesis-testing may lead to a systematic bias against the welfare of species or populations that are in need of protective action (NRC, 1995, Chapter 8). Analyzing risks with the framework of decision analysis increases the probability that all types of errors and their consequences are adequately considered.

Advances in technology have enabled the use of computer-intensive methods in risk assessment (e.g., Slooten et al., 2000; Taylor et al., 2000). If relevant data on marine mammals are lacking, this kind of simulation approach can benefit from the use of data on other species selected on the basis of life history, ecology, or body size (e.g., Caswell et al., 1998). Bayesian decision theory, which allows choices among more than two decisions, offers many advantages and is increasingly recommended for use in risk assessment related to natural-resources management (Ludwig, 1996; Taylor et al., 1996; Wade, 2000).

FINDING: Focused effort is needed on a modeling exercise that should include demographic models, IBMs, and categorical modeling. Such an effort should start with, and calibrate against, expert opinion and should incorporate such characteristics as

- An aim to pull together what is known—in different ways, from different disciplines—and to assess both the importance and the degrees of uncertainty associated with the information.

- The use of tactical models, with the objective of probing how successfully current knowledge could be applied.
- The use of structured models to test hypotheses.
- The use of models to identify crucial gaps in knowledge. (A gap in knowledge is not just something we do not know; it is something we do not know and need to know if we are to meet our objectives.)
- An aim to encourage interdisciplinary synthesis and provide a structure for it.
- The requirement that all modeling efforts be explicit about uncertainty and its consequences.
- A similar requirement that all models clearly state their limited purpose and that both their strengths and their shortcomings be evaluated.
- A risk assessment for the species being modeled if the model is to be used for management decisions.

RECOMMENDATION 5: Several marine mammal species for which there are good long-term demographic and behavioral data on individuals should be selected as targets of an intensive exploratory modeling effort that would develop a series of individual-based models and stage- or age-structured demographic models for the species as appropriate. NOAA Fisheries should bring together an independent, interdisciplinary panel of modelers and relevant empirical scientists that would meet periodically to pursue the modeling effort collaboratively in an iterative and adaptive manner with the long-term goal of developing tools to support informed, practical decision-making.

Species should be chosen on the basis of how extensively they have been studied, and the models should concentrate on populations (or subpopulations) in which individual animals are known and have been tracked for some time. The different species should be chosen to span an array of life-history patterns (such as feeding and breeding strategies). The objectives of the modeling exercises should be to speculate on how harassment or acoustic injury of individuals might affect populations and to identify gaps in data and understanding. The exercises should also explore links between IBMs and demographic analyses for the same population; each should be able to inform the other in important ways (see Caswell and John, 1992). Some candidate populations for such a study are the Puget Sound killer whales (Krahn et al., 2002), the North Atlantic right whales (*Eubalaena glacialis;* Waring et al., 2003), bottlenose dolphins in Sarasota Bay (Wells, 2003), the gray seals of Sable Island (Austin et al., 2004), and the northern elephant seals of Año Nuevo Island (LeBoeuf et al., 2000). All those have been studied extensively, and individual animals have been identified and resighted over multiple years. For most of the populations, the demographics are well defined; in some, the effects of major environmental stressors, such as an El Niño or the North Atlantic Oscillation, have been observed (Fujiwara and Caswell, 2001; Greene and Pershing, 2004). Such complex interdisciplinary modeling has been undertaken by the National Center for Ecological Analysis and Synthesis at the University of California, Santa Barbara.

4

Rational Management with Incomplete Data

The committee's task statement requires placing this scientific review within the context of management.

> Recognizing that the term "biologically significant" is increasingly used in resource management and conservation plans, this study will further describe the scientific basis of the term in the context of marine mammal conservation and management related to ocean noise.

As noted in this report, the full predictive model is at least a decade away from coming to fruition, and the management requirements involved in addressing concerns over ocean-noise effects on marine mammals are extremely pressing. Efforts are under way to address the long-term goal of producing the predictive model outlined here, but an interim plan is needed. One strategy is to implement a management regimen that uses available data, agreed upon management goals, and a conservative approach to the insufficiencies of the available data. The regimen should encourage data acquisition to reduce uncertainty. At the workshop the NOAA Fisheries Potential Biological Removal (PBR) model was discussed as such an example.

The three acts of Congress most relevant to regulating exposure of marine mammals to noise are the National Environmental Policy Act of 1969 (NEPA), the Marine Mammal Protection Act of 1972 (MMPA), and the Endangered Species Act of 1973 (ESA). The NEPA focuses on environmental analysis of "the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity." The goal of the MMPA is to "replenish any species or population stock which has diminished below its optimum sustainable level," but its basic regulatory tool involves a prohibition on "taking" marine mammals, where *take* is defined as "to harass, hunt, capture or kill, or attempt to harass, hunt, capture or kill." Similarly, the ESA aims to "conserve endangered species and threatened species and the ecosystems upon which they depend," but it also relies on a prohibition of taking individual animals. The prohibition on taking marine mammals made sense when the dominant conservation problems involved directed hunting and animals incidentally killed by commercial fishing. It is much more difficult to relate harassment takes to population effects.

A number of the workshop panelists agreed that the concept of Potential Biological Removal (PBR) (Taylor et al., 2000) as developed by scientists at NOAA Fisheries, and the concept of the revised management procedure (Cooke, 1994) as developed by scientists associated with the International Whaling Commission, represented the best current approaches to management of human effects on marine mammals under conditions of inadequate data. This chapter reviews the PBR concept and suggests how harassment and other takes could be incorporated into it. The PBR concept is attractive because it is based on a small number of clearly defined and easily understood variables. The limits of acceptable population impact determine the allowable removals. Extensive modeling and sensitivity analysis confirmed that the selected parameter values ensured, with high probability, that the population impacts would be within the prescribed bounds. Anyone who feels that the allowed removals are set either too low or too high can present new data and interpretation in peer-reviewed publications that NOAA Fisheries uses in stock assessments and establishment of PBR.

FINDING: Development of a model, such as the PCAD model, to inform regulatory decisions is critical for a full understanding of the biological significance of anthropogenic noise on marine mammal populations, but a more immediate solution is necessary.

> **RECOMMENDATION 6: A practical process should be developed to help in assessing the likelihood that specific acoustic sources will have adverse effects on a marine mammal population by disrupting normal behavioral patterns. Such a**

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process should have characteristics similar to the Potential Biological Removal model, including

- **Accuracy,**
- **Encouragement of precautionary management—that is more conservative (smaller removal allowed)—when there is greater uncertainty in the potential population effects of induced behavioral changes,**
- **Being readily understandable and defensible to the public, legal staff, and Congress,**
- **An iterative process that will improve risk estimates as data improve,**
- **An ability to evaluate cumulative impacts of multiple low-level effects, and**
- **Being constructed from a small number of parameters that are easy to estimate.**

POTENTIAL BIOLOGICAL REMOVAL

The 1994 reauthorization of the MMPA introduced a new regime to determine when the number of animals killed or seriously injured by commercial fisheries poses a risk to marine mammal stocks. It involves estimating the number of animals that could be "removed" from a marine mammal stock without stopping the stock from reaching or maintaining its optimal sustainable population (16 U.S.C. 1362(3)20). The number is called the PBR. Under this regime, every fishing vessel is required to register with NOAA Fisheries. As long as the operators of the vessel register, accept an observer on board, report every marine mammal that they find killed or seriously injured, and comply with the requirements of regulations adopted under a take-reduction plan, all the requirements under the MMPA have been met. In effect, they are exempt from the prohibition on harassment.

For each marine mammal stock, the number of animals killed or seriously injured is compared with the PBR. If NOAA Fisheries learns of sources of mortality, such as a ship strike, the animals are added to the total, but there is no systematic effort to monitor nonfishing kills.[1] If the number

[1]From the Marine Mammal Commission's 2002 report to Congress: "The Commission also questioned the Service's decision to include data on fishery- and other human-related

of animals taken is above the PBR, the regimem calls for a take-reduction team to be formed and to determine ways to reduce the take. The take-reduction team is required to recommend management actions that will reduce the take to below the PBR within 6 months and to the zero-mortality goal within 5 years. A rule establishing 10% of the PBR as zero mortality was published in the July, 20 2004, *Federal Register*.

The calculation of the PBR provides an example of a model designed for management and decision-making. The criteria used for this model are these (Taylor et al., 2000):

- Input parameters are based on available data.
- Uncertainty is incorporated into the model. Managers must make decisions despite uncertainty, but decisions grow more conservative with greater uncertainty.
- There is a mechanism for demonstrating that decisions based on the model meet the MMPA management goals.

Before 1994, the MMPA prohibited any kills of marine mammals in stocks that were below an optimal sustainable population (OSP). The MMPA defines OSP on the basis of the theory of density-dependent population growth. The OSP is defined as the maximal net productivity level (MNPL), which is the population size that theoretically yields the greatest growth rate. The MMPA characterized populations that fell below the MNPL as depleted. During the first 20 years of the MMPA, however, it proved difficult to estimate the parameters required to determine when a population reached the critical point of depletion. Given that uncertainty and the draconian consequences of a “depleted” designation, few populations were designated as depleted, and depletion designations did not fare well in court.

The PBR model was developed in response to the difficulty in parameter estimation. The PBR model selected inputs on the basis of the

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mortalities and serious injuries only when incidents could be confirmed. In the Commission’s view, requiring confirmation runs counter to the precautionary principle built into the Marine Mammal Protection Act and would tend to result in underestimates. Similarly, the Commission took issue with conclusions in some assessment reports, particularly those for the Alaska region, that certain effects were not occurring because they had not been observed. The Commission cautioned that such conclusions of no-effect should be based, in part, on monitoring effort being made to detect such effects.”

experience that the three parameters most easily estimated for most marine mammals were abundance, the uncertainty of abundance, and maximal growth rate. The PBR is calculated as follows:

$$PBR = 0.5N_{min} R_{max} F_r$$

where N_{min} is the minimum population estimate, R_{max} is the maximal population growth rate, and F_r is a recovery factor ranging from 0.1 to 1.0. Qualitatively, it should be clear that the larger the population and the faster it is capable of growing, the more animals can be removed from the population without impeding its recovery. The equation for PBR was not derived from population modeling, however, but through modeling to evaluate its ability to meet, with a 95% probability, the following management goals based on the MMPA (Taylor et al., 2000):

- Healthy populations will remain above OSP numbers for the next 20 years.
- Recovering populations will reach OSP numbers after 100 years.
- Populations at high risk will not be delayed in reaching OSP numbers by more than 10% beyond the predicted time that is based on an absence of human-induced mortality.

Biologists at NOAA Fisheries tested various values for the input parameters to decide on the values most likely to meet management goals.

The PBR model incorporates two features that are desirable in a model to be used for management decisions (Taylor et al., 2000). It uses parameters that are readily available, and it is conservative when there is uncertainty. For example, the use of the minimal population estimate takes an immediately conservative approach while research to refine the population estimate is stimulated. That is particularly true when the take is near the PBR and the minimal population estimate leads to a PBR well below that calculated by using the mean population estimate. The validity of the PBR is based on how well the result meets explicit management objectives.

EXTENSION OF PBR

PBR should be extended in two ways. First, it needs to incorporate mortality outside the regulated fishing industries. Second, it needs to consider effects on populations that result from the summation of multiple sublethal impacts on individuals. Although the PBR regime was initially developed to regulate commercial fisheries, it cannot achieve the goals of the MMPA if activities other than fisheries contribute to mortality and these takes are not counted accurately and tallied with the fishery takes. For example, NOAA Fisheries has instituted a costly scheme of using professional monitors on vessels to count animals that are entangled in fishing gear, and fisheries are required to report deaths and serious injuries. In many fisheries, however, animals may be killed or injured in lost gear, and this is unlikely to be detected by monitoring on the fishing vessels (Laist, 1996). Similarly, animals immobilized in fishing gear may be taken by predators or may become disentangled after injury or death and not be counted. The regulations requiring reporting of lethal takes and serious injuries are limited to fisheries, so the accounting of takes in nonfishery activities is not as accurate.

The NOAA Fisheries stock assessments are improving their reporting of takes in such activities as vessel strikes, but without a reliable mechanism for monitoring and reporting it is nearly impossible to estimate the number of takes in a given activity. There may be additional uncounted lethal takes from a variety of sources, including exposure to intense noise.

The potential for such takes of Cuvier's beaked whales in association with naval sonar was reflected in the NOAA Fisheries 2002 stock assessment for Cuvier's beaked whales in the western North Atlantic. The assessment lists 46 fisheries-related beaked whale deaths from 1989 to 1998, 53 beaked whales stranded from 1992 to 2000, and 14 beaked whales stranded in the Bahamas in association with a naval sonar exercise. The assessment points out other associations between mass strandings of beaked whales and the presence of naval vessels (NMFS, 2002, pg. 50)

> Although a species-specific PBR cannot be determined, the permanent closure of the pelagic drift gillnet fishery has eliminated the principal known source of incidental fishery mortality. The total fishery mortality and serious injury for this group is less than 10% of the calculated PBR and, therefore can be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because of uncertainty regarding stock size and evidence of human induced mortality and serious injury associated with acoustic activities.

The stock assessment states that the stock is strategic because of acoustic activities, now that the fishery rate is low. This is a clear example of where the PBR mechanism cannot protect marine mammals unless NOAA

Fisheries develops a mechanism for accurate reporting of all sources of human-induced mortality.

FINDING: During the last decade, the PBR mechanism has proved to be a successful model to account for the cumulative effects of lethal takes and serious injuries in commercial fisheries. However, as currently implemented, the PBR mechanism cannot adequately protect marine mammals from all sources of human-induced mortality until all such mortality is included in a revised and expanded PBR regime.

RECOMMENDATION 7: Improvements to PBR are needed to reflect total mortality losses and other cumulative impacts more accurately:

- **NOAA Fisheries should devise a revised PBR regime in which all sources of mortality and serious injury can be authorized, monitored, regulated, and reported in much the same manner as is currently done by commercial fisheries under Section 118 of the MMPA.**
- **NOAA Fisheries should expand the PBR model to include injury and behavioral disturbance with appropriate weighting factors for severity of injury or significance of behavioral response (cf. NRC, 1994, p. 35).**

The PBR is intended as a mechanism to trigger regulatory action when the cumulative effects of taking reach some threshold. It uses the number of individuals removed from the population as the unit for assessing cumulative effect. Individuals are taken when they are killed, but taking also includes serious injury, minor injury, and behavioral disturbance. Rather than the current practice of counting serious injury as equal to death and injury as equivalent to no effect, it would be appropriate to develop a severity score for each kind of take defined by the MMPA. A severity score estimates the proportional effect of a given take activity compared with that of a lethal take. A precise estimate of the proportion would require integration of behavioral effects into demographic models—one of the most challenging aspects of the PCAD model. However, it may be possible to set several categories of severity for injury and behavioral harassment. Two categories per order of magnitude would probably provide appropriate precision (for example, 1, 0.3, 0.1, 0.03, 0.01, 0.003).

The visible signs of injury listed by NOAA Fisheries[2] include injuries of obviously varied severity. They include

- Loss of or damage to an appendage, jaw, or eye; these injuries affect the long-term ability of an animal to swim, feed, or see.
- Entanglement in fishing gear; it may take days or weeks for an animal to free itself from a serious entanglement, which may also leave long-term injuries.
- Bleeding, laceration, swelling or hemorrhage; some of these may reflect a serious injury, but they often resolve in a few days with little long-term consequence.

To address Recommendation 7, NOAA Fisheries could convene an expert panel of veterinarians to assign injury severity scores for those and other symptoms. For example, it seems likely that the first category might score 0.3, the second category 0.1, and the third category 0.01. Although some of the animals with the symptoms may have more or less severe effects, as long as the severity score is at least as great as the effect on the average animal compared with being killed, the scoring should be conservative for use in the PBR. The research necessary to validate that would involve following the outcomes of injured animals for their ability to survive, grow, breed, and provide parental care.

Just as the cumulative effects of nonserious injuries cannot be ignored, so an analysis of cumulative effects must add the adverse effects of behavioral harassment. Behavioral harassment is likely to be both less severe and more common than injury. That makes it all the more important to evaluate the cumulative effects on a stock of all harassment takes in addition to injury and lethal takes. For example, the dominant model of effects of noise posits different zones of influence at different distances from the source (Figure 4-1).

Assigning a severity score to harassment would involve a process similar to that used for injury but would require experts in behavioral ecology instead of veterinary care. Assuming that harassment is not involved indirectly in causing injury or death (as may occur with effects of military sonar on beaked whales), the primary effects of harassment involve the loss of opportunities, time, and energy. If the proposed activity occurs at a criti-

[2]http://www.nmfs.noaa.gov/prot_res/PR2/Fisheries_Interactions/MMAP.htm

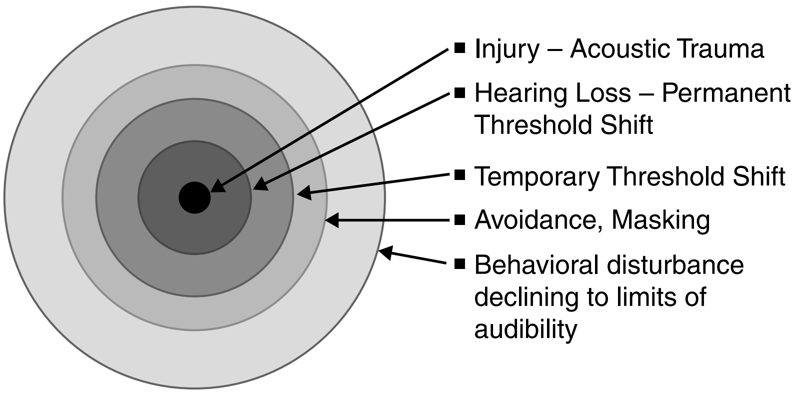

FIGURE 4-1. Close to an intense source, sound may be loud enough to cause death or serious injury. Somewhat farther away, an animal might have less serious injury, such as hearing loss. Temporary threshold shifts occur at greater distances. Animals may avoid exposures at even greater distances or they may not move from the area but still be affected through masking of important auditory cues from the environment. They may show just observable behavioral disturbance at distances comparable with the limit of audibility. The different distances for the different effects define different areas for each zone.
SOURCE: Modified from Richardson and Malme, 1993.

cal time or in a critical place when a specific activity must occur (for example, it disrupts a critical feeding trip of a phocid seal or disturbs a breeding site during a short season), the severity score will be higher. Thus, for a species for which the cost of a lost breeding season reflects the postponement to the next season and for an individual expected to have well in excess of 10 breeding seasons, the severity of loss of a breeding season might be set at 0.1; if the expectation is well in excess of 30 breeding seasons, the severity of loss of a breeding season might be set at 0.03. For activities that are expected to expose animals for shorter times during less critical periods, the time and energy lost may dominate interpretation of severity. One of the most pronounced behavioral responses of a marine mammal to noise involves the response of beluga whales to icebreakers in the Arctic. Beluga whales may respond to an icebreaker at many tens of kilometers (LGL and

Greeneridge, 1986; Cosens and Dueck, 1988; Finley et al., 1990). Their normal behavior is disrupted for several days, and they may have an increased metabolic rate as they swim away from an oncoming vessel. Other animals in other settings may show disruption of behavior for minutes to hours. In those cases, the severity score may be based on time lost and excess energy expended. Many species have seasonal changes in their behavioral ecology, with seasons lasting around 100 days, so a first approximation might divide the expected duration of disruption, in days, by 100. The result could be rounded to the next higher severity score. Thus, if an activity would be expected to disrupt an animal for less than 0.1 day (2.4 hr), the severity would be 0.1/100 = 0.001. If the disruption would be expected to last minutes, the severity might be set a .003/100 = 0.00003. As with the severity score for injury, an expert panel could be convened to establish severity scores for different kinds of behavioral disruption.

Severity scores can be used in the calculation of PBR by multiplying the number of animals affected by each severity (N) times the severity score (S) itself, and then tallying all of the N*S values. Table 4-1 illustrates the expectation that the higher the severity score, the fewer animals expected to be impacted, but in addition it illustrates how leaving out the cumulative effects of injury and harassment may underestimate cumulative impacts. In this hypothetical example, with an unrealistic assumed density of 1 animal/ 3.14 m^2, there is 1 lethal take, the equivalent of 1 lethal take in 10 injuries, and the equivalent of 1 lethal take in 100 cases of behavioral harassment. If PBR is to correctly tally cumulative impacts, it cannot completely ignore effects with severity of <1.

TABLE 4-1 Arbitrary Ranges and Severity Levels to Illustrate the Relation Between Severity of Effect and Numbers of Animals Affected (for most species, a two-dimensional approximation is appropriate)

Effect	Range (m)	Severity (S)	Relative Area (πr^2)	Number of Animals (N)	(N)*(S)
Death or serious injury	1	1	3	1	1
Injury (such as hearing loss)	10	0.01	314	100	1
Behavioral Disturbance	100	0.0001	31,416	10,000	1
TOTAL					3

DETERMINATION OF NONSIGNIFICANT IMPACT

The proposed modifications of the PBR model cannot be accomplished easily or quickly. The original PBR model was the result of many years of development and analysis. Prior sections of this report have emphasized the long time-line for acquiring the data and understanding necessary for a full implementation of the PCAD model. Compliance with the current regulatory interpretations of the NEPA, the MMPA, and the ESA is fraught with uncertainty regarding the use of sound sources in the marine environment and as the 2000 National Research Council report noted, regulations are more effective when they target critical disturbances.

The statement of task for this study was initially framed as identify biologically significant effects, but from a regulatory perspective it is more important right now to suggest a process for identifying activities that do *not* reach a de minimis standard for biological significance. Such activities would be exempt from the normal permitting process.

To assist regulatory agencies in meeting the requirements of the MMPA, a formalized, intelligent-decision system for risk assessment that uses current research expertise could offer the following advantages:

- It could provide a rapid and more simple authorization procedure, reducing the burden on applicants and regulators.
- It could provide a tally of each effect in a format that could account for cumulative effects.
- It could stimulate the generation of data required to make determinations in a format that makes the data readily available for the next applicant.
- It could improve decisions by improving available data.
- It could encourage others to report problems (such as, strandings) and to identify unexpected potential problems.
- It could set conditions for permits on the basis of location, time, and ecological conditions.
- It could maintain permanent records of every application.
- It could require applicants who apply and fail to meet a de minimis standard to obtain permits as under the current system.
- It could institute an adaptive system to improve data incrementally, and to reflect updates from annual reviews.

An Internet-based system, described in Figure 4-2 could assist producers of sound in the sea to determine whether proposed activities

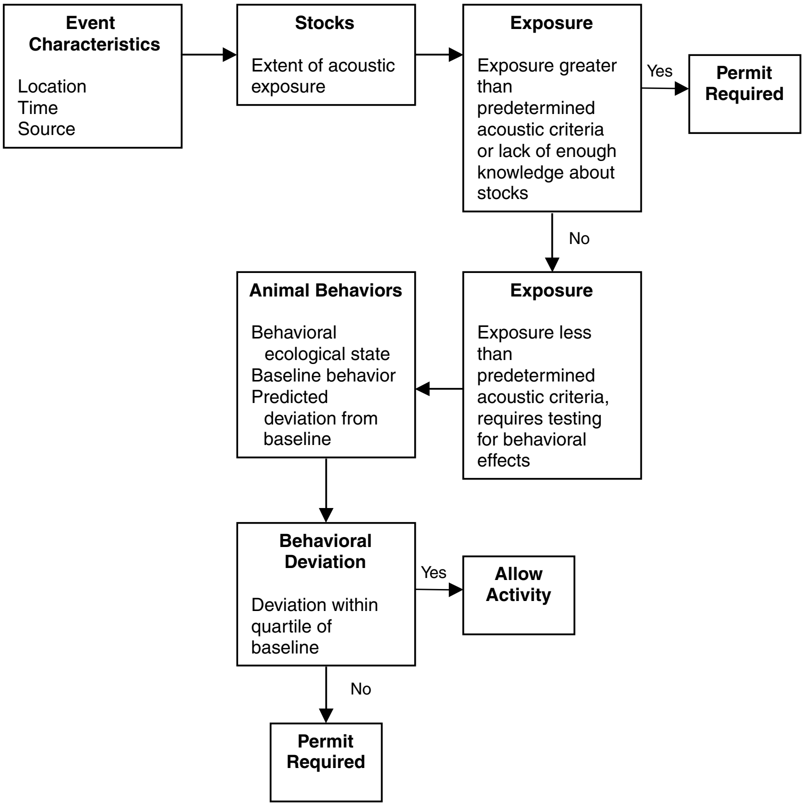

FIGURE 4-2. Diagram of a possible system for determination of whether behavioral changes cross a de minimis threshold.

require a permit or may be considered exempt from permitting. Essentially, such a process would allow regulators to establish de minimis standards that identify activities that have a low probability of causing changes in marine mammal behavior that would lead to significant population effects. This system would be populated initially with rules that, given our current state of knowledge, can best be attained through expert opinion. Although the model presented is based on animal exposure to sound, it is equally applicable to other types of activities affecting marine mammals.

In the initial stage of the process for applying for the de minimis exemption, for any kind of effect on marine mammals, the applicant would state the location and time of the proposed activity. The spatial scope of most effects is relatively easy to define. Sound travels so well in water that determining the scope of acoustic effects requires more information. For acoustic effects, the applicant would also state the acoustic characteristics of the proposed source: for example, source level, rise time, spectrum, directionality, and time course of operation.

Because most marine mammal populations are below their OSP, the system should be conservative in the face of uncertainty, that is, it should avoid the type of error that would lead to the loss of a valued resource (NRC, 1995). Such conservativeness might be reflected in a requirement for a specified level of knowledge about the distribution of animal populations, known as stocks for management purposes, within hearing range of the source. If enough is known about the stocks and their distribution, the system would move to the next stage; if not, it would reject the application for "no significant effect" determination unless the applicant could obtain and enter the required information.

The initial format of this part of the system would be based on a geographical information system (GIS). It could build on several continuing efforts to develop GIS systems that store information about the distribution and abundance of stocks (such as the Ocean Biogeographical Information System Spatial Ecological Analysis of Megavertebrate Populations, http://seamap.env.duke.edu) with geographical data on sound propagation. The common database described in Recommendation 3 could be used to populate this part of the system. The raw sighting data used by NOAA Fisheries for stock assessments would be a major component of the marine mammal element of the GIS for US waters. The acoustic information could be used to define how the sound would spread from the proposed site.

The initial stage in evaluating whether potential effects of a sound source cross the de minimis threshold would use the NOAA Fisheries acoustic criteria described in Chapter 3. For each species in the area, the exposure to sound from the planned sources is evaluated in terms of the criterion threshold for sound pressure level or energy level for the functional hearing group to which the species belongs. If the probability that individuals are exposed above the threshold level for acoustic effects is less than, for example, 0.001, the species would pass the proposed de minimis standard for direct acoustic exposure.

Animals experiencing exposures below the direct acoustic-effects threshold may still have behavioral reactions that could lead to population consequences. The next step is to determine the level of effect on life functions (Box 4-1).

BOX 4-1
Considerations for Evaluating Marine Mammal Disturbances by Specific Activities

Determining biologically significant disturbance would necessarily evaluate a number of behaviors and their ecological contexts in regard to the proposed activities. Below are some behaviors that theoretically can be disrupted by noise, and some considerations in the determination of significance of the disruptions. The examples are illustrative only and should not be construed as a complete catalog of potentially biologically significant behavioral disruptions.

Migration. For migration, the standard might state that neither the path length nor the duration of migration could be increased into the upper quartile of the normal time or distance of migration. Fully one-fourth of the population exceed this value normally, so this is likely to be a conservative criterion. With enough data on time and length of migration, the applicant could then use response models or estimates of the scope of the effect to evaluate whether they meet the criterion. For example, if the effect of the activity extends for only a small duration of migration or a small part of the migratory path, such data alone might be sufficient. For migrating gray whales, in which case avoidance can be quantitatively related to a received level of sound, more-detailed analyses might be applied to a measure to account for the reduced uncertainty.

Feeding. For feeding behavior, the standard might be related to whether the disturbance will decrease energy reserves into the lower quartile of normal variation, as measured during a period appropriate for the proposed activity and season and the species affected. For example, female marine mammals can be divided into capital breeders, which postpone reproduction until they have stored enough energy to carry infants through to weaning, and income breeders, which continue to make foraging trips during lactation (Costa, 1993). Different periods would be integrated for the different classes and different energy measures, such as energy stores or reserves vs. daily energy balance.

The behavior of marine mammals varies by species, age-sex class, location, season, and time. The effect on life functions of a given change in behavior will also depend on those variables. The effect can be modulated

Breeding. Different standards for disruption of breeding behavior should be considered for females and males. The ability of a female to select a mate, breed, gestate, and give birth to a viable offspring is so essential to populations that there should be very low tolerance of disturbances that might affect these activities. The disruption of male reproductive behavior is probably less likely to have population effects than would disruption of female reproductive behavior, although disruption of male behavior should not reduce the pool of potential mates from which females can choose by more than 25%. This might be estimated from known changes in male call characteristics in response to noise, if the typical distribution of males and disturbance-caused movements of females are sufficiently known, the scope of disturbance could be estimated.

Nurturing and Parental Care. Very low thresholds should be considered for any disturbance that might separate a dependent infant from its caregivers. Examples include analyzing whether noise or disturbance responses might cause the infant and caregivers to separate too far to resume their activities. On longer time scales, the program could analyze whether the disturbance might reduce the nutrition from lactation to less than the lower quartile of normal. Both the duration of nursing bouts and the distribution of intervals between bouts may be important. It is possible that males in some species, such as Baird's beaked whales (*Berardius bairdii;* Kasuya et al., 1997), may be important for parental care and infant survival. Undisturbed social structure may be particularly important for infant survival. For example, bottlenose dolphin calves raised in large, more stable groups have higher survival than those raised in smaller, less stable groups (Wells, 1993).

Predator Avoidance. For behavioral changes that alter the response to predators, very low thresholds are recommended if there is the chance that the disruption will increase the vulnerability of an animal to predation. Many marine mammals depend on social defenses from predation (Mann et al., 2000).

by interannual ecological changes, such as El Niño or the North Atlantic Oscillation. Because the science is not mature enough for predictive modeling from behavior of individuals to population effects, a simple interim criterion based on normal variation of undisturbed behavior could be used. The baseline behavior against which behavioral changes are measured should be mapped onto the time and location of the proposed activity as closely as possible. Where other contexts, such as the phase of the interannual cycle, are known to affect behavior, they should be taken into account.

The de minimis criterion should be robust and conservative in the face of small samples and ignorance of shape of the distribution of baseline behavior. It should also be set at a level that meets management goals. A reasonable starting point would be a quartile level (upper or lower, as appropriate), but the value selected for this criterion should be tested with the same kinds of models used to evaluate the performance of the calculation of PBR (Taylor et al., 2000).

In all cases in which the proposed system yields a "no-significant-impact" determination and the applicant does not have to prepare a permit application, NOAA Fisheries should require the applicant to register the activity, monitor for effects, and report observed effects to the system to improve the knowledge base for future determinations. Approved stranding networks should enter all stranding data. The Internet-based system could be queried for any planned activities, and anyone could look for correlations between activities and strandings. After accumulating data for a few years, the database would allow epidemiological research that should be able to identify such problems as the effects of mid-range tactical sonar on beaked whales in less than the 35 years that it took to make this particular connection.

Experts and managers should meet annually, at least initially, to evaluate the performance of the system and to revise decision criteria on the basis of new information. Such a system, if applied to all activities, would provide rich opportunities for epidemiological analyses of the data to identify hot spots and linkages between human activities and marine mammal mortality or morbidity.

Any cases of lethal take or serious injury should be reported immediately and should be added to the take that is compared with the PBR. Any such take should disqualify the activity for the "no significant impact" determination and for regulation under the de minimis standard. Any applicant who provides false information to the system in an attempt to avoid permitting requirements should be disqualified from using the system and be subject to prosecution.

FINDING: Current knowledge is insufficient to predict which behavioral changes in response to anthropogenic sounds will result in significant population consequences for marine mammals. The PCAD model and proposed revisions to the PBR will take years to implement. In the interim, those who introduce sound into the marine environment and those who have responsibility for regulating takes resulting from such activities need a system whereby reasonable criteria can be set to determine which sounds will have a nonsignificant impact on marine mammal populations. Collectively, there are sufficient expert knowledge and extensive databases to establish such a system and to set the non-significant-impact criterion conservatively enough that there can be broad agreement on it.

RECOMMENDATION 8: An intelligent-decision system should be developed to determine a de minimis standard for allowing proposed sound-related activities. An expert-opinion panel should be constituted to populate the proposed system with as many decision points as current information and expert opinion allow. The system should be systematically reviewed and updated regularly.

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Appendixes

Appendix A

Committee and Staff Biographies

Douglas Wartzok (Chair) is the vice-provost for academic affairs, dean of the University Graduate School, and professor of biology of Florida International University. Dr. Wartzok served as the associate vice-chancellor for research, dean of the graduate school, and professor of biology at the University of Missouri-St. Louis for 10 years. For the last 30 years, his research has focused on sensory systems of marine mammals and the development of new techniques to study the animals and their use of sensory systems in their natural environment. He and his colleagues have developed acoustic tracking systems for studying seals and radio and satellite tracking systems for studying whales. For 8 years, he edited *Marine Mammal Science*, he is now editor emeritus. Dr. Warzok served on the National Research Council panel that produced the report *Ocean Noise and Marine Mammals* (2003).

Jeanne Altmann is a professor in the Department of Ecology and Evolutionary Biology at Princeton University, a member of the National Academy of Sciences, and a fellow of the Animal Behavior Society. Dr. Altmann pioneered the quantitative study of ecology, demography, and genetics of wild primates and standardized methods for observation of behavior. She carried out groundbreaking work on selection pressures on mothers and established the baseline against which primate life-history studies are compared. Dr. Altmann's current research centers on the magnitude and sources of variability in primate life histories, parental care, and behavioral ontogeny. She is analyzing sources of variability in baboon groups and examining patterns in baboon stability in groups and populations. Her major research interests include nonexperimental research design and analysis and behavioral aspects of conservation. Dr. Altmann has a BA in mathematics and a PhD in behavioral sciences.

Whitlow Au is the chief scientist of the Marine Mammal Research Program at the Hawaii Institute of Marine Biology. He performs research on auditory processes, signal processing, and echolocation primarily in dolphins and whales but also in other species. His research involves psychophysical testing, electrophysiological measurements, underwater acoustics measurements, computer modeling of auditory systems, and artificial neural network computations. Dr. Au is interested in the bioacoustics of marine organisms, from the detection and characterization of sounds to their social and ecologic implications. Dr. Au served as a reviewer on earlier National Research Council reports and is a member of the NRC's Ocean Studies Board.

Katherine Ralls is a senior scientist at the Smithsonian Institution's National Zoological Park. She has broad interests in behavioral ecology, genetics, and conservation of mammals, both terrestrial and marine. Her early research focused on mammalian scent marking, sexual dimorphism, the behavior of captive ungulates, and inbreeding depression in captive mammals and laid the foundations for the genetic and demographic management of captive populations. She is known for her research on endangered and threatened mammals in the western United States, particularly sea otters and kit foxes. Dr. Ralls is a fellow of the Animal Behavior Society and received the Merriam Award from the American Society of Mammalogists and the LaRoe Award from the Society of Conservation Biology. She has served on two previous National Research Council panels.

Anthony M. Starfield is a professor of ecology, evolution and behavior at the University of Minnesota. He obtained a BSc in applied mathematics in 1962 and a PhD in mining engineering in 1965 at the University of the Witwatersrand, Johannesburg. As an applied mathematician, Dr. Starfield uses quantitative modeling as the bridge between science and management, with particular interest in conservation management. His projects have been as diverse as a population model of the Hawaiian monk seal and a model to explore the likely consequences of climate change for the Alaskan tundra. Dr. Starfield has taught workshops on modeling and decision analysis to over 800 conservation scientists and resource managers around the world during the last 10 years. He chaired the annual review committee of the Earth Sciences Division of Lawrence Berkeley Laboratory in 1989 and 1995.

Peter L. Tyack earned his PhD in animal behavior from Rockefeller University in 1982. His research interests include social behavior and vocalizations of cetaceans, including vocal learning and mimicry in their natural communication systems and their responses to human noise. Dr. Tyack has been a senior scientist at the Woods Hole Oceanographic Institution since 1999. He served on National Research Council panels that examined the effects of low-frequency sound on marine mammals in 1994 and 2000.

STAFF

Jennifer Merrill is a senior program officer of the Ocean Studies Board (OSB), and has directed studies since 2001. She earned her PhD in marine and estuarine environmental science from the University of Maryland Center for Environmental Science, Horn Point Laboratory. She directed the National Research Council studies that led to the reports on *Marine Biotechnology in the Twenty-first Century: Problems, Promise, and Products* (2002), *Ocean Noise and Marine Mammals* (2003), and *Exploration of the Seas: Voyage into the Unknown* (2003). In addition, she assisted with the report *Oil in the Sea III* (2003) and the Committee to Review Activities Authorized Under the Methane Hydrate Research and Development Act of 2000, and she serves as the OSB staff contact for the International Council of Scientific Union's Scientific Committee on Oceanic Research.

Sarah Capote is a senior program assistant with the Ocean Studies Board. She earned her BA in history from the University of Wisconsin-Madison in 2001. During her tenure with the board, Ms. Capote has worked on the following reports: *Exploration of the Seas: Voyage into the Unknown* (2003), *Nonnative Oysters in the Chesapeake Bay* (2004), *Future Needs in Deep Submergence Science: Occupied and Unoccupied Vehicles in Basic Ocean Research* (2004), the interim report *Elements of a Science Plan for the North Pacific Research Board* (2004), and *A Vision for the International Polar Year 2007-2008* (2004).

Appendix B

Acronyms

AIM	Acoustic Integration Model
ATOC	Acoustic Thermometry of the Ocean Climate
CEE	Controlled Exposure Experiment
ESA	Endangered Species Act
ESME	Effects of Sound on the Marine Environment
FWS	US Fish and Wildlife Service
GIS	Geographic Information System
IBM	Individual-Based Model
LFA	Low-Frequency Active
MMPA	Marine Mammal Protection Act of 1972
MNPL	Maximum Net Productivity Level
NCEAS	National Center for Ecological Analysis and Synthesis
NEPA	National Environmental Policy Act of 1969
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration

NRC	National Research Council
ONR	Office of Naval Research
OSP	Optimum Sustainable Population
PBR	Potential Biological Removal
PCAD	Population Consequences of Acoustic Disturbance
PTS	Permanent Threshold Shift
SPAWAR	Space and Naval Warfare Systems Center
SURTASS	Surveillance Towed Array Sensor System
TTS	Temporary Threshold Shift

Appendix C

Workshop Agenda and Participants List

Predicting Population Consequences of the Disturbance by Noise on Marine Mammals
National Academy of Sciences
Lecture Hall
2101 Constitution Avenue NW
Washington, DC
March 5-6, 2004

Friday, March 5, 2004

Open Session

Opening remarks, committee introductions, review of workshop format
Douglas Wartzok—Florida International University, Chair
Joanne Bintz—Study Director, Ocean Studies Board

Introduction to Task Statement and Model

PANEL I—INDIVIDUALS TO POPULATIONS
Session Introduction—**Katherine Ralls**
Shripad Tuljapurkar, Dean and Virginia Morrison Professor of Population Studies, Stanford University
Bill Morris, Associate Professor, Department of Biology, Duke University

Bruce Kendall, Assistant Professor, Donald Bren School of Environmental Science & Management, University of California, Santa Barbara

PANEL II—FUNCTIONAL MODULATION OF EFFECTS

Session Introduction—**Jeanne Altmann**

L. Michael Romero, Associate Professor, Department of Biology, Tufts University

Daniel P. Costa, Professor, Department of Ecology and Evolutionary Biology, University of California, Santa Cruz

S.A.L.M. Kooijman, Professor, Department of Theoretical Biology, Vrije Universiteit, Amsterdam

PANEL III—TRANSFER FUNCTION MODELING

Session Introduction—**Anthony Starfield**

Wayne Getz, Department of Environmental Science, Policy and Management, University of California, Berkeley

Gordon Swartzman, Research Professor, Applied Physics Laboratory, University of Washington

Daniel Goodman, Director, Environmental Statistics Group, Montana State University

Saturday, March 6, 2004

Open Session

Opening remarks—**Douglas Wartzok**, Committee Chair

PANEL IV—RESPONSES & MODELS FROM THE MANAGEMENT WORLD

Session Introduction—**Peter Tyack**

Bob Kull, Program Manager, Parsons

Jay Barlow, Program Leader, Southwest Fisheries Science Center, and Adjunct Professor, Scripps Institution of Oceanography

Jean Cochrane, Wildlife Biologist, US Fish and Wildlife Service, Endangered Species Program, Arlington, VA

PARTICIPANTS LIST

Committee Members:

Douglas Wartzok (Chair)**,** *Florida International University*
Jeanne Altmann, *Princeton University*
Whitlow Au, *University of Hawaii*
Katherine Ralls, *Smithsonian Institution, National Zoological Park*
Anthony Starfield, *University of Minnesota*
Peter Tyack, *Woods Hole Oceanographic Institution*

Speakers:

Jay Barlow, *Scripps Institution of Oceanography*
Jean Cochrane, *US Fish and Wildlife Service*
Daniel P. Costa, *University of California, Santa Cruz*
Wayne Getz, *University of California, Berkeley*
Daniel Goodman, *Montana State University*
Bruce Kendall, *University of California, Santa Barbara*
S.A.L.M. Kooijman, *Vrije Universiteit, Amsterdam*
Bob Kull, *Parsons*
Bill Morris, *Duke University*
L. Michael Romero, *Tufts University*
Gordon Swartzman, *Applied Physics Laboratory*
Shripad Tuljapurkar, *Stanford University*

Attendees:

Dan Allen, *ChevronTexaco Exploration Production Company*
Laurie Allen, *National Oceanic and Atmospheric Administration*
Charles Bedell, *Murphy Oil Corporation*
Sue Belford, *Jacques Whitford Environment Limited*
Lee Benner, *Minerals Management Service*
Daryl Boness, *Smithsonian Institution, National Zoological Park*
Mel Briscoe, *Office of Naval Research*
Jack Caldwell, *WesternGeco*
Ben Chicoski, *National Oceanic and Atmospheric Administration*
Tara Cox, *Marine Mammal Commission*
Cythia Decker, *Oceanographer of the Navy*

Bridget Ferriss
Phil Fontana, *Veritas Marine Acquisition*
Kellie Foster, *National Oceanic and Atmospheric Administration*
Amy Fraenkel, *Senate Committee on Commerce, Science, and Transportation; Subcommittee on Oceans, Fisheries, and Coast Guard*
Ann Garrett, *National Oceanic and Atmospheric Administration*
Roger Gentry, *National Oceanic and Atmospheric Administration*
Bob Gisiner, *Office of Naval Research*
Mardi Hastings, *Office of Naval Research*
Frank Herr, *Office of Naval Research*
Bob Houtman, *Office of Naval Research*
Mi Ae Kim, *National Marine Fisheries Service*
Karen Kohanowich, *Assistant Secretary of the Navy for Environment*
Anurag Kumar, *Geo-Marine Inc.*
Stan Labak, *Marine Acoustics, Inc.*
David Laist, *Marine Mammal Commission*
Todd McConchie, *George Mason University*
Roger Melton, *ExxonMobil Upstream Research Company*
Harriet Nash, *National Oceanic and Atmospheric Administration*
Patrick O'Brien, *ChevronTexaco Energy Technology Company*
Tim Ragen, *Marine Mammal Commission*
Wallie Rasmunssen, *ExxonMobil Corporation*
Michael Rawson, *Lamont-Doherty Earth Observatory*
Nan Reck, *National Oceanic and Atmospheric Administration*
Naomi Rose, *Humane Society of the United States*
Bill Schmidt, *National Park Service*
Randy Showstack, *Reporter, EOS*
Brandon Southall, *National Oceanic and Atmospheric Administration*
Frank Stone, *Chief of Naval Operations*
Maya Tolstoy, *Lamont-Doherty Earth Observatory*
Kathleen Vigness Raposa, *Marine Acoustics, Inc.*
Erin Vos, *Marine Mammal Commission*
Brian Weitz, *Senate Committee on Commerce, Science, and Transportation; Subcommittee on Oceans, Fisheries, and Coast Guard*
Andrew Wigton, *ExxonMobil Upstream Research Company*
Sheyna Wisdom, *URS Corporation*
Nina Young, *Ocean Conservancy*

Staff:

Susan Roberts, *Acting Board Director*
Joanne Bintz, *Study Director*
Jennifer Merrill, *Study Director*
Sarah Capote, *Program Assistant*

Appendix D

Draft Conceptual Plan for Workshop Discussion

DEFINITION OF THE PROBLEM

Throughout human history oceans have been important for transportation and commerce, biological and physical resource extraction, and defense. However, the vast expanse of the oceans precluded significant human impact until the coming of the industrial revolution. The transition from wind driven to mechanized shipping, was the first step in a continued increase in the initially unintentional and subsequently, with the development of sonar, intentional introduction of sound into the ocean. Because of the low loss characteristics of sound transmission, compared to light transmission, the use of sound had developed evolutionarily as the predominant long-range sensory modality for marine species. Thus as human use of the oceans increased with a concomitant increase in anthropogenic sound in the ocean, the conflict with evolutionarily adapted marine animals sound sensing systems was inevitable.

Over 90 percent of the global trade is transported by sea. Shipping is the dominant sound in the world's oceans at between 5 and 500 Hz. At other frequencies, anthropogenic noise does not predominate in the ocean sound energy budget, but can have important local impacts. For instance, seismic air guns associated with geophysical exploration for locating new oil and gas deposits run hundreds of thousands of miles of survey lines in just the Gulf of Mexico each year. In addition, commercial sonar systems are on all but the smallest pleasure craft. These sonars allow for safer boating and shipping, and more productive fishing. Military sonar systems are important for national defense.

This intentional and unintentional introduction of sound in the ocean associated with activities beneficial to humans must be balanced against known deleterious effects on marine mammals. Strandings of beaked whales in certain environments are clearly associated with the use of mid-range tactical military sonar. There are documented behavioral responses of beluga whales to icebreakers 50 km away. Gray whales and killer whales have shown multi-year abandonment of critical habitats in response to anthropogenic noise. Although there are many documented, clearly discernable responses of marine mammals to anthropogenic sound, reactions are typically subtle, consisting of shorter surfacings, shorter dives, fewer blows per surfacing, longer intervals between blows, ceasing or increasing vocalizations, shortening or lengthening duration of vocalizations, and changing frequency or intensity of vocalizations. Although some of these changes become statistically significant in given exposures, it remains unknown when and how these changes translate into biologically significant effects at either the individual or the population level.

The basic goal of marine mammal conservation is to prevent human activities from threatening marine mammal populations. The threat from commercial whaling was obvious, but it is harder to estimate the population consequences of activities that have less immediately dramatic outcomes, such as those with indirect or small but persistent effects. The life histories and habitat of marine mammals compounds these problems. Marine mammals are long lived and slow to mature. Many species have long periods of dependency. They are highly social and show behavioral plasticity, with complex development of behavior. Furthermore, many of these behaviors occur underwater where they are difficult to document. This makes it particularly difficult to estimate the effects that a short term exposure may have as it ripples through the lifetime of an individual, or as effects on different individuals ripple through the population. Even extreme effects, including death, are not necessarily observed.

The status of any population is the consequence of the accumulation of many effects; resulting in marginal changes in survival and reproduction over time. In addition, the end result is often so far removed in time from the proximate causal events that they cannot simply be traced post hoc. The existence of several comparable populations with different status and different exposure can be used to reduce the number of candidate primary causes of the decline. However, often such comparative populations are lacking.

One way around this conundrum, well tested for issues of human health, is to study how individuals respond to exposure in the short term. Behavior and physiology are rapid response systems evolved to compensate for environmental variation within established limits. A standard method to evaluate risks of exposure to chemicals involves analyzing the short-term physiological responses to specific doses of a compound. Similar studies have been conducted to investigate how marine mammals respond to known exposures to sound. The goal of the NRC Committee on Characterizing Biologically Significant Marine Mammal Behavior is to develop a framework to relate short term acoustic dose:behavioral response relationships to potential population consequences.

HISTORY OF NRC REPORTS

The NRC has produced three reports on the effects of noise on marine mammals, in 1994, 2000 and 2003. The primary goal of the 1994 report was to recommend research on this topic, but the report noted that regulation of marine mammal research impeded critical research, and the report had an entire chapter on regulatory burdens. This chapter of the 1994 report focused especially on harassment of marine mammals. It pointed out that:

> Logically, the term harassment would refer to a human action that causes an adverse effect on the well-being of an individual animal or (potentially) a population of animals. However, "the term 'harass' has been interpreted through practice to include any action that results in an observable change in the behavior of a marine mammal. . . ." (Swartz and Hofman, 1991, p. 27)
>
> As researchers develop more sophisticated methods for measuring the behavior and physiology of marine mammals in the field (i.e. via telemetry), it is likely that detectable reactions, however minor and brief, will be documented at lower and lower received levels of human-made sound. . . . In that case, subtle and brief reactions are likely to have no effect on the well being of marine mammal individuals or populations. (Swartz and Hofman, 1991, p. 28)

The 2000 NRC report also has a chapter on regulatory issues focusing on acoustic harassment. This chapter continued to emphasize the importance of a criterion for significance of disruption of behavior: "It does not make sense to regulate minor changes in behavior having no adverse impact; rather regulations must focus on significant disruption of behaviors critical to survival and reproduction …" (Swartz and Hofman, 1991, p 68). It went on to suggest a redefinition of Level B harassment as follows:

> Level B—has the potential to disturb a marine mammal or marine mammal stock in the wild by causing meaningful disruption of biologically significant activities, including, but not limited to, migration, breeding, care of young, predator avoidance or defense, and feeding. (Swartz and Hofman, 1991, p. 69)

The third report of the NRC, *Ocean Noise and Marine Mammals (2003)*, attempted to look at the world ocean noise budget between 1 and 200,000 Hz with particular attention to habitats that were important to marine mammals. The basic question the report tried to address was: What is the overall impact of human-made sound on the marine environment? The somewhat unsatisfactory answer was that the overall impact is unknown, but there is cause for concern. Other than shipping, the overall energy contribution of anthropogenic sound to the ocean noise budget is insignificant. However, total energy contribution is not the best currency to use in determining potential impact of human-made sound on marine organisms. The report made a number of recommendations with the overarching one being the need to better understand the characteristics of ocean noise, particularly from man-made sources and its potential impacts on marine life, especially those that may have population level consequences.

STATEMENT OF TASK

The statement of task for the present NRC Committee, the *Committee on Characterizing Biologically Significant Marine Mammal Behavior*, picks up on two issues noted above: the difference between statistically significant and biologically significant changes in behavior; and linking those short-term behavioral changes to possible population level consequences. The term "biologically significant" enjoys wide use in conservation and management literature, and increasingly in regulatory agency guidelines, but has not been well defined. The committee has been tasked to define "biologically significant" within the context of marine mammal behavioral responses to ocean acoustic sources with particular reference to those responses affecting marine mammal populations. The committee will produce a brief report that reviews and characterizes the current scientific understanding of when animal behavior modifications induced by transient and non-transient ocean acoustic sources, individually or cumulatively, could threaten marine mammal stocks. Recommendations will be based on input from a scientific workshop, consideration of the relevant literature, and other sources.

GOAL, PROPERTIES AND OUTPUT

Develop a conceptual framework and produce a practical process to help regulators assess the risk that specific acoustic sources will have negative impacts on a marine mammal population by disrupting normal behavioral patterns.

Desirable properties of such a process include one that is: accurate; precautionary and becomes more precautionary with greater uncertainty in the potential population level effects of the induced behavioral changes; is simple and transparent to the public, legal staff, and congress; leads to an iterative process which will improve risk estimates as data improve; is able to evaluate cumulative impacts of multiple low level disturbances; and ends up with a small number of parameters that are easy to estimate.

COMMITTEE CONCEPTUAL APPROACH

We propose a process to link acoustic stimuli to behavioral responses to functional outcomes of responses integrated over daily and seasonal cycles in a way that links to life history models. This sequence of stages is essential to link population models, which for seasonal breeders are typically structured on an annual basis, with studies that relate acoustic exposure to behavioral response, that typically work on time scales of hours.

Table D-1 diagrams our approach. On the left we characterize the acoustic features of the sound stimulus of interest. The first stage of our framework involves a transfer function to predict behavioral responses to this sound. Ideally this function derives from controlled exposure experiments, supplemented by observational or correlational studies. This transfer function may vary depending upon the species, season, location, and age-sex of the subject. In the absence of data for the precise situation of interest, marine mammals should be grouped in this stage of the framework by their hearing capabilities, and only data from the same ear type should be used.

TABLE D-1 Transfer functions weighted by season, location, demographic characteristics. Topics highlighted in **bold** were emphasized at the workshop.

Sound	X-Fcn 1	Behavior Change	X-Fcn 2	Function Impacted	**X-Fcn 3**	Population Effect
Transformation Function Modeling						
		Orientation		Life		
Freq		Breathing		Migration		Survival
Duration		Vocalizing		Feeding		Children
Level		Diving		Breeding		Grandchildren
Source		Resting		Nurturing		
Duty Cycle		Mother-Infant		Response to Predator		
		Spatial relationships	**Homeostasis/Risk Factor (Allostasis)**			
		Avoidance	**Time and Energy**			

The output of the first transfer function predicts changes in observable behaviors or physiological measures as a function of sound exposure. The second stage of our framework must evaluate how much these changes in behavior compromise processes that are widely recognized as critical to life history. Where possible, we propose to break down these functional consequences into two time scales—diurnal and seasonal. Most marine mammals respond to diurnal changes with a cycle of activities that suggests the validity of integrating short term functional consequences over a minimum duration typical of the activity in undisturbed animals up to durations of 24 h when possible. These time scales can be studied with behavioral observations or tagging methods. Most marine mammals also show strong seasonal variations in behavior and physiology. As a first cut, our framework will then sum expected daily consequences over each season, depending upon expected exposure schedule to the sound of interest.

The output of the second transfer function defines over a season, the extent to which exposure to a sound may have interfered with the subject's ability to perform behavioral functions that may be critical to survival, growth, and reproduction. The third stage of our framework must estimate what impact this interference may have at the population level. We propose that this stage involves matrix population models structured to stratify each season by the amount of interference. Ideally this would involve models where there is some basis for estimating exposure and thus amount of interference for each individual or age-sex class, depending upon how the model is structured. The function relating interference to population effect ideally would derive from several years of observation of survival and reproduction in a population where effects of exposure can be predicted. For the purposes of this report, we will need to develop a preliminary method to estimate the likelihood of population effect.

SOUND

Ocean acoustic sounds can have a wide range of effects on marine mammals varying from minor annoyances to potentially deleterious effects on a population level. The sources of acoustic noise have been well described in the 2003 National Research Council's (NRC) Ocean Studies Board report, which also described a variety of effects of noise on marine mammals. The discussion of the effects of noise on marine mammals in the 2003 NRC report concentrated on individual marine mammals with the implication that if enough individuals are affected in the same manner, then the population will be affected. In this discussion, the focus will be on the effects of ocean acoustics that will have negative consequence on marine mammals on the population level.

We will attempt to understand how different acoustic sources could modify behavior and hinder marine mammals from performing critical functions that could eventually have an impact on the population level. There are many questions concerning how acoustic signals can modify behavior on a time scale that would affect a population of marine mammals. Among various parameters of acoustic signals that should be considered include bandwidth, frequency range, intensity, modulation type, modulation rate, duration and duty cycles need to be considered. However, at our current level of understanding there is little understanding how any of these parameters, whether individually or corporately can affect or modify marine mammal behavior. Even in a simple case, we would expect that a narrow-band acoustic source will have little effectiveness in disturbing a dolphin's ability to echolocate. Then the question is how broad in bandwidth does the acoustic interference need to be to disrupt or interfere with a dolphin's ability to echolocate? There are many similar questions to which there are no obvious answers.

BEHAVIOR

Behavioral changes typically occur over time ranges of minutes to hours. The responses often increase monotonically with increasing signal intensity, but such changes are rarely linear. They are also strongly influenced by other signal characteristics such as frequency, rise time, duty cycle, novelty, and total energy content. The variability in behavioral responses is as likely due to changes in the state, condition, demographic status, or location of the animal as to characteristics of the sound source. Repeated presentations of the signal typically result in habituation in which the response is not as pronounced to subsequent signal presentations, but the converse can also occur in which the response becomes greater on subsequent presentations of the same signal, a condition known as sensitizitation. Individual variability of animals significantly reduces the capability of predicting behavioral change in response to acoustic stimuli.

FUNCTION

All organisms must perform a set of behavioral and physiological functions in order to survive, grow, and reproduce. Marine mammals must have effective ways to avoid predation, feed, breed, and take care of their young. Many species migrate over long distances, and all must orient on smaller scales. Many pelagic species dive between the surface where they must breathe and great depths where they find and consume prey.

Each of these behavioral activities may be affected by acoustic interference in different ways with different functional consequences. The main costs of interference are risks of injury, opportunity costs due to not detecting a signal, and costs of lost time and extra energy expenditure. If a diving animal responds to sound in a way that pushes the limits of diving physiology, the behavioral response itself could cause injury. If noise stimulates seals to stampede on a beach, or stimulates a cetacean to strand, this could cause death or injury. Similarly if an animal fails to detect an oncoming predator because of interfering noise, it could be killed or injured.

Interpreting the indirect effects where behavioral responses to sound may injure or kill a marine mammal is straightforward. The other costs of lost opportunities, time, or energy require more interpretation to infer the consequences. If an animal incorrectly responds to a noise as if it were a predator, this response entails the costs of lost time and energy. A migrating animal could be affected in two different ways. If it uses acoustic cues to orient for migration, exposure to noise sufficient to mask these cues might interfere with orientation. Some migrating animals avoid exposure to noise; this deflection costs time and energy. If exposure to noise interferes with feeding, the primary costs are time lost if prey items are missed, and energy costs of lost prey intake and potentially increased costs of locomotion. The likely costs of noise to breeding and parental care both involve the costs of not detecting signals and the energy and time costs of any mechanisms they may have for compensating for noise to improve the probability of signal detection in noise. However, the consequences differ. In species that use acoustic communication in the mating system, a female might in the worst case fail to find a mate while she was receptive. This problem is likely to be worst for depleted populations that do not aggregate in mating centers. Noise may also interfere with the process by which males compete during the breeding season, by which females select a mate. All marine mammal young are dependent upon parental care. Many species use acoustic communication both to maintain contact between mother and young, and also for mother-offspring recognition. If increased noise prevented or delayed mother and young from reuniting after a separation, this could have negative consequences for the young. Many marine mammals learn their vocalizations. We are only just beginning to understand the intricacies of vocal development in marine mammals, but increased noise might interfere with development of a fully functional system of vocal communication.

OPERATIONAL PLANS

The Committee held its first meeting 6–8 October 2003 at the National Academy of Sciences in Washington, D.C. and prepared this document conceptualizing and outlining a proposed approach to addressing the statement of task. The committee also identified those areas in which it needed assistance in completing the model leading from stimulus through a determination of biologically significant behavioral change to a population level effect. Four primary areas where additional expertise was needed were identified. For each of those areas, experts will be identified and invited to the next meeting of the committee on 5–8 March 2004, again at the National Academy of Sciences in Washington, D.C. That meeting will begin with a two day workshop. On the first day each of the invited experts will make a 15 minute presentation on how the gaps in the model can be bridged and how the deficiencies in the model can be rectified. On the morning of the second day, the experts within each area will meet together with one member of the committee to put together a synthesis and improvement of the individual presentations of the day before. In the afternoon, each of the four working groups will make a presentation to the full committee. The committee will spend the final two days in closed session writing the report.

TRANSFER FUNCTION WORKING GROUP

The overall purpose of the proposed model is three-fold. The first two purposes derive directly from the statement of task, identifying biologically significant behavioral changes and linking those changes to population level effects. The third purpose is to assist regulators in determining the likelihood that a given stimulus will lead to a specific behavioral change affecting a defined biological function which results in a given change in an identified population parameter. Between each of these operational units there are transfer functions which can be weighted by a variety of external factors such as season, location, and demographic characteristics of the exposed animals. Given the current state of knowledge, the committee recognizes that likelihood factors cannot be categorized on a finer scale than high, moderate or low. The Transfer Function Modeling expert group will help the committee turn this heuristic model into an operational one.

SOLICITATION OF PARTICIPATION

We are all too aware of the questions and uncertainty surrounding our task. On the other hand, decisions affecting the fate of these populations must be made. We face the task given to us not with confidence that we can solve all the problems, but rather in the hope that the framework we develop can help to provide a scientific basis for ranking research and management priorities.

We are soliciting your participation not only in helping to fill in significant areas in which the committee lacks sufficient experience or knowledge, but also your perspective, often from a very different background and experience, as to the overall approach of the committee to the statement of task. This model is being presented very much as a work in progress and we hope you will take this opportunity to help the committee to shape this model, or to convince the committee to abandon this model. Thank you.

Appendix E

Scientific and Common Names

Order Carnivora

Family Felidae

Puma concolor coryi	Florida Panther
Family Mustelidae	
Enhydra lutris	Sea otter
Family Odobenidae	
Odobenus rosmarus	Walrus
Family Otariidae	
Zalophus californianus	California sea lion
Eumetopias jubatus	Steller sea lion
Family Phocidae	
Mirounga augustirostris	Elephant seal
Halichoerus grypus	Gray seal
Phoca vitulina	Harbor seal
Phoca hispida	Ringed seal
Leptonychotes weddellii	Weddell seal

Order Cetacea

Family Balaenidae

Eubalaena glacialis	North Atlantic right whale
Family Balaenopteridae	
Megaptera novaeangliae	Humpback whale

Family Delphididae	
Tursiops truncatus	Bottlenose dolphin
Pseudorca crassidens	False killer whale
Orcinus orca	Killer whale
Family Eschrichtiidae	
Eschrichtius robustus	Western gray whale
Family Kogiidae	
Kogia sima	Dwarf sperm whale
Kogia breviceps	Pygmy sperm whale
Family Monodontidae	
Delphinapterus leucas	Beluga whale (=white whale)
Monodon monoceros	Narwhal
Family Phocoenidae	
Phocoena phocoena	Harbor porpoise
Family Physeteridae	
Physeter macrocephalus	Sperm whale
Family Ziphiidae	
Berardius bairdii	Baird's beaked whale
Mesoplodon densirostris	Blainville's beaked whale
Ziphius cavirostris	Cuvier's beaked whale
Order Gadiformes	
Family Gadidae	
Theragra chalcogramma	Walleye pollock
Order Rodentia	
Family Muridae	
Peromyscus maniculatus	Wild Deer mouse
Order Squamata	
Family Iguanidae	
Amblyrhynchus cristatus	Marine iguana

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NOAA Technical Memorandum NMFS

JANUARY 2013

U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENTS: 2012

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NOAA-TM-NMFS-SWFSC-504

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

Revised 12/18/2012

GRAY WHALE (*Eschrichtius robustus*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Once common throughout the Northern Hemisphere, the gray whale became extinct in the Atlantic by the early 1700s (Fraser 1970; Mead and Mitchell 1984), though one anomalous sighting occurred in the Mediterranean Sea in 2010 (Scheinin *et al*. 2011). Gray whales are now found in the North Pacific where two extant populations are currently recognized (Reilly *et al*. 2008). Recent genetic comparisons suggest that these two stocks, called the "Eastern North Pacific" (ENP) and "Western North Pacific" (WNP) populations, are distinct, with differentiation in both mtDNA haplotype and microsatellite allele frequencies (LeDuc et al. 2002; Lang et al.2011a).

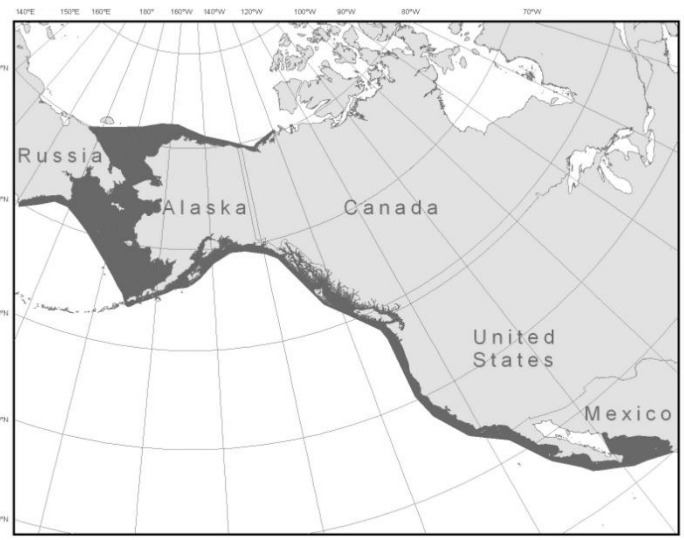

Figure 1. Approximate distribution of the Eastern North Pacific stock of gray whales (shaded area).

During summer and fall most whales in the ENP population feed in the Chukchi, Beaufort and northwestern Bering Seas (Fig. 1). An exception to this generality is the relatively small number (100s) of whales that summer and feed along the Pacific coast between Kodiak Island, Alaska and northern California (Darling 1984; Calambokidis *et al.* 2002, 2010; Gosho *et al.* 2011). By late November, the southbound migration is underway as whales begin to travel from summer feeding areas to winter calving areas off the west coast of Baja California, Mexico, and the southeastern Gulf of California (Rugh *et al*. 2001; Swartz *et al.* 2006). The southbound migration is segregated by age, sex and reproductive condition (Rice and Wolman 1971). The northbound migration begins about mid-February and is also segregated by age, sex and reproductive condition.

Gray whale breeding and calving are seasonal and closely synchronized with migratory timing. Sexual maturity is attained between 6 and 12 years of age (Rice 1990; Rice and Wolman 1971). Gestation is estimated to be 13 months, with calving beginning in late December and continuing to early February (Rice and Wolman 1971). Some calves are born during the southbound migration while others are born near or on the wintering grounds (Sheldon *et al*. 2004). Females produce a single calf, on average, every 2 years (Jones 1990). Calves are weaned and become independent by six to eight months of age while on the summer feeding ground (Rice and Wolman 1971). Three primary calving lagoons in the ENP are utilized during winter, and some females are known to make repeated returns to specific lagoons (Jones 1990). Genetic studies suggest that some substructuring may occur on the wintering grounds, with significant differences in mtDNA haplotype frequencies found between females (mothers with calves) utilizing two of the primary calving lagoons and females sampled in other areas (Goerlitz *et al*. 2003). Other research utilizing both mtDNA and microsatellites identified significant departure from panmixia between two of the lagoons using nuclear data, although no significant differences were identified using mtDNA (Alter *et al.* 2009).

The distribution and migration patterns of gray whales in theWNP are less clear. The main feeding ground is in the Okhotsk Sea off the northeastern coast of Sakhalin Island, Russia, but some animals occur off eastern Kamchatka and in other coastal waters of the northern Okhotsk Sea (Weller *et al*. 2002; Vertyankin *et al*. 2004; Tyurneva *et al*. 2010). Some WNP whales migrate south in autumn, but the migration route(s) and winter breeding ground(s) are poorly known. Information collected over the past century indicates that whales migrate along the coasts of Japan and South Korea (Andrews 1914; Mizue 1951; Omura 1984) to wintering areas somewhere in the South China Sea, possibly near Hainan Island (Wang 1984). No sightings off South Korea have been reported in over a decade, however. Results from photo-identification (Weller *et al*. 2011), genetic (Lang 2010; Lang *et al*. 2011a) and telemetry studies (Mate *et al*. 2011) have documented mixing between the WNP and ENP, including observations of six whales photographically matched from Sakhalin Island to southern Vancouver Island, and two whales genetically matched from Sakhalin to Santa Barbara, California. Combined results from photo-ID and genetics studies reveal that a total of 8 gray whales have been observed in both the WNP and ENP (Weller *et al.* 2011; International Whaling Commission (IWC) 2011a). Despite this level of mixing, significant mtDNA and nuclear genetic differences are found between whales in the WNP and those summering in the ENP.

Population structure within the ENP is less clear. Recent studies provide new information on gray whale stock structure within the ENP, with emphasis on whales that feed during summer off the Pacific coast between northern California and southeastern Alaska, occasionally as far north as Kodiak Island, Alaska (Gosho *et al.* 2011). These whales, collectively known as the "Pacific Coast Feeding Group" (PCFG), are a trans-boundary population with the U.S. and Canada and are defined by the IWC as follows: gray whales observed between 1 June to 30 November within the region between northern California and northern Vancouver Island (from 41°N to 52°N) and photo-identified within this area during two or more years (IWC 2011a; IWC 2011b; IWC 2011c). In 2005, the Makah Indian Tribe requested authorization from NOAA/NMFS, under the MMPA and the Whaling Convention Act, to resume limited hunting of gray whales for ceremonial and subsistence purposes in the coastal portion of their usual and accustomed (U&A) fishing grounds off the coast of Washington State (NMFS 2008). The spatial overlap of the Makah U&A and the summer distribution of PCFG whales has management implications. The proposal by the Makah Tribe includes time/area restrictions designed to reduce the probability of killing a PCFG whale and to focus the hunt on whales migrating to/from feeding areas to the north. Similarly, observations of gray whales moving between the western and eastern North Pacific highlights the need to estimate the probability of a WNP gray whale being taken during a hunt by the Makah Tribe (IWC 2011a; IWC 2011b). NMFS has published a notice of intent to prepare an environmental impact statement (EIS) on the proposed hunt (NMFS 2012) and the IWC is evaluating the potential impacts of a hunt on the PCFG (IWC 2011a; IWC 2011c; IWC 2011b).

Photo-identification studies from 1998 to 2008 between northern California and northern British Columbia provide data on the abundance and population structure of PCFG whales (Calambokidis *et al.* 2010). Gray whales using the Pacific Northwest during summer and autumn include two components: **1)** whales that frequently return to the area, display a high degree of intra-seasonal "residency" and account for a majority of the sightings between 1 June and 30 November. Despite movement and interchange among sub-regions of the study area, some whales are more likely to return to the same sub-region where they were observed in previous years. **2)**"visitors"from the northbound migration that are sighted only in one year, tend to be seen for shorter time periods in that year, and are encountered in more limited areas.

Satellite tagging studies between 3 September and 4 December 2009 off Oregon and California provide movement data for whales considered to be part of the PCFG (Mate *et al.* 2010). Duration of tag attachment differed between individuals, with some whales remaining in relatively small areas within the larger PCFG seasonal range and others traveling more widely. All six individuals whose tags continued to transmit through the southbound migration utilized the wintering area within and adjacent to Laguna Ojo de Liebre (Scammon´s lagoon). Three whales were tracked north from Ojo de Liebre: one traveled at least as far as Icy Bay, Alaska, while the other two were tracked to coastal waters off Washington (Olympic Peninsula) and California (Cape Mendocino). In addition to satellite tag data, photographic evidence has shown that some presumed PCFG whales move at least as far north as Kodiak Island, Alaska (Calambokidis *et al.*2010; Gosho *et al.* 2011). The satellite tag and photo-ID data suggest that the range of the PCFG may, at least for some individuals, exceed the pre-defined 41°N to 52°N boundaries that have been used in PCFG-related analyses (e.g. abundance estimation).

Previous genetic studies of PCFG whales focused on evaluating recruitment patterns, with simulations indicating detectable mtDNA genetic differentiation would result if the PCFG originated from a single colonization event in the past 40 to 100 years, without subsequent external recruitment (Ramakrishnan and Taylor, 2001). Subsequent empirical analysis, however, failed to detect differences when 16 samples collected from known PCFG whales utilizing Clayoquot Sound, British Columbia, were compared with samples (n=41) collected from individuals presumably feeding farther north (Steeves *et al.* 2001). Additional genetic analysis with an extended set of samples (n=45) collected from whales within the PCFG range indicated that genetic diversity and the number of mtDNA haplotypes were greater than expected (based on simulations) if recruitment into the PCFG were exclusively internal (Ramakrishnan *et al.* 2001). However, both simulation-based studies focused on evaluating only the hypothesis of founding by a single and recent colonization event and did not evaluate alternative scenarios, such as recruitment of whales from other areas into the PCFG (Ramakrishnan and Taylor 2001; Ramakrishnan *et al.* 2001). More recently, Frasier *et al.* (2011) compared mtDNA sequence data from 40 individuals within the seasonal range of the PCFG with published sequences generated from 105 samples collected from ENP gray whales, most of which stranded along the migratory route (LeDuc *et al.,* 2002). The mtDNA haplotype diversity found among samples of the PCFG was high and similar to the larger ENP samples, but significant differences in mtDNA haplotype distribution and in estimates of long-term effective population size were found. Based on these results, Frasier *et al.* (2011) concluded that the PCFG qualifies as a separate management unit under the criteria of Moritz

(1994) and Palsbøll *et al.* (2007). The authors noted that the PCFG likely mates with the rest of the ENP population and that their findings were the result of maternally-directed site fidelity of whales to different feeding grounds.

A subsequent study by Lang *et al.* (2011b) assessed stock structure of whales utilizing feeding grounds in the ENP using both mtDNA and eight microsatellite markers. Significant mtDNA differentiation was found when samples from individuals (n=71) sighted over two or more years within the seasonal range of the PCFG were compared to samples from whales feeding north of the Aleutians (n=103) as well as when the PCFG samples were compared to the subset of samples collected off Chukotka, Russia (n=71). No significant differences were found when these same comparisons were made using microsatellite data. The authors concluded that (1) the significant differences in mtDNA haplotype frequencies between the PCFG and whales sampled in the northern areas indicates that the utilization of some feeding areas is being influenced by internal recruitment (e.g., matrilineal fidelity), and (2) the lack of significance in nuclear comparisons suggests that individuals from different feeding grounds may interbreed. The level of mtDNA differentiation identified, while statistically significant, was low and the mtDNA haplotype diversity found within the PCFG was similar to that found in the northern strata. Lang *et al.* (2011b) suggested that these findings could be indicative of relatively recent colonization of the PCFG but could also be consistent with a scenario in which external recruitment into the PCFG is occurring.

After reviewing results from photo-identification, telemetry, and genetic studies available in 2010 (i.e. Calambokidis *et al.* 2010; Mate *et al.* 2010; Frasier *et al.* 2011), the IWC agreed that the hypothesis of the PCFG being a demographically distinct feeding group was plausible and warranted further investigation (IWC 2011a). Recent research by Lang *et al.* (2011b) provided further support for recognition of the PCFG as a distinct feeding aggregation. Because the PCFG appears to be a distinct feeding aggregation and may warrant consideration as a distinct stock in the future, separate PBRs are calculated for the PCFG within this report. Calculation of a PBR for this feeding aggregation allows NMFS to assess whether levels of human-caused mortality are likely to cause local depletion within this population.

POPULATION SIZE

Systematic counts of gray whales migrating south along the central California coast have been conducted by shore-based observers at Granite Canyon most years since 1967 (Fig. 2). The most recent southbound counts were made during the 2007/2008, 2009/2010, and 2010/2011 surveys, from which abundance estimates are not yet available.

The most recent estimate of abundance is from the 2006/2007 southbound survey, or 19,126 (CV=7.1%) whales (Laake *et al.* 2009). Because of observed interannual differences in correction factors used to correct for bias in estimating pod size (Rugh *et al.* 2008), the time series of abundance estimates dating back to 1967 was reanalyzed. Laake *et al.* (2009) developed a more consistent approach to abundance estimation that used a better model for pod size bias and applied their estimation approach to re-estimate abundance for all 23 surveys.

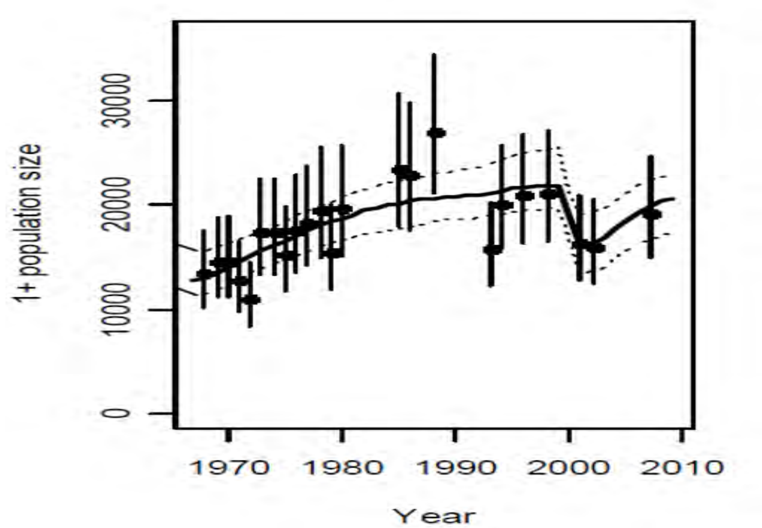

Figure 2. Estimated abundance of Eastern North Pacific gray whales from NMFS counts of migrating whales past Granite Canyon, California. Error bars indicated 90% probability intervals. The solid line represents the estimated trend of the population with 90% intervals as dashed lines (after Punt and Wade 2010).

The new abundance estimates between 1967 and 1987 were generally larger than previous abundance estimates; differences by year between the new abundance estimate and the old estimate range from -2.5% to 21%. However, the opposite was the case for survey years 1992 to 2006, with estimates smaller (-4.9% to -29%) than previous estimates. This is largely explained by differences in the correction for pod size bias, because the pod sizes in the calibration data were positively-biased. Re-evaluation of the correction for pod size bias and the other changes made to the estimation procedure yielded a somewhat different trajectory for population growth. The estimates still show the population increased steadily from the 1960s until the 1980s. Previously, the peak abundance estimate was in 1998 followed by a large drop in numbers (Rugh *et al*. 2008). Now the peak estimate is a decade earlier in 1987/88. The revised estimates for the most recent years are 16,369 (CV=6.1%) in 2000/01, 16,033 (CV=6.9%) in 2001/02, and 19,126 (CV=7.1%) in 2006/07. Revised estimates from the three years prior are 20,103 (CV=5.6%) in 1993-94, 20,944 (CV=6.1%) in 1995-96, and 21,135 (CV=6.8%) in 1997-98 (Laake *et al*. 2009).

Gray whale counting methods were updated with a new counting technique during the 2006/2007 migration where two observers and a computer are used to log and track individual pods (Durban *et al.* 2010). This replaces a long-used method of a single observer recording sightings on paper forms. The two-observer method allows for a higher frequency of observations of each whale pod, because one observer is dedicated solely to observing pods, while a second observer's primary role is data recording and software tracking of pods. Evaluations of both counting techniques during simultaneous (2006/2007 and 2007/2008) and independent (2006/2007, 2007/2008, 2009/2010, and 2010/2011) trials have been completed (Durban *et al*. 2010, 2011) and correction factors for the new approach are presently being estimated (Durban *et al*. 2011).

Photographic mark-recapture abundance estimates for PCFG gray whales between 1998 and 2008, including estimates for a number of smaller geographic areas within the more broadly defined PCFG region, are reported in Calambokidis *et al*. (2010). These estimates were further refined during an inter-sessional workshop of the IWC (IWC 2011b). The 2008 abundance estimate for the defined range of the PCFG between 41°N to 52°N is 194 (SE = 17.0) whales.

Eastern North Pacific gray whales experienced an unusual mortality event in 1999 and 2000, when large numbers stranded along the west coast of North America (Moore *et al*., 2001; Gulland *et al*., 2005). Over 60% of the dead whales were adults, and more adults and subadults stranded in 1999 and 2000 relative to years prior to the mortality event (1996-98), when calf strandings were more common. Many stranded whales were emaciated and aerial photogrammetry documented that gray whales were thinner in 1999 relative to previous years (Perryman and Lynn, 2002). Several factors suggest that the high mortality rate was a short-term, acute event and not a chronic situation or trend: 1) in 2001 and 2002, strandings of gray whales along the coast decreased to levels that were below their pre-1999 level (Gulland *et al*., 2005); 2) average calf production in 2002-2004 returned to levels seen before 1999; and 3) in 2001, living whales no longer appeared to be emaciated. A Working Group on Marine Mammal Unusual Mortality Events (Gulland *et al*., 2005) concluded that the emaciated condition of many stranded whales supported the idea that starvation could have been a significant contributing factor to the higher number of strandings in 1999 and 2000. Unusual oceanographic conditions in 1997 may also have decreased productivity in the Bering Sea (Minobe 2002). Regardless of the mechanism, visibly emaciated whales (LeBoeuf *et al*. 2000; Moore *et al*. 2001) suggest a decline in available food resources, and it is clear that ENP gray whales were substantially affected in those years; whales were skinnier, they had a lower survival rate (particularly of adults), and calf production was dramatically lower. A modeling analysis estimates that 15.3% of the non-calf population died in each of the years of the mortality event, compared to about 2% in a normal year (Punt and Wade 2010). The most recent abundance estimate from 2006/07 suggests the population has nearly increased back to levels seen in the 1990s before the mortality event in 1999 and 2000 (Figure 2).

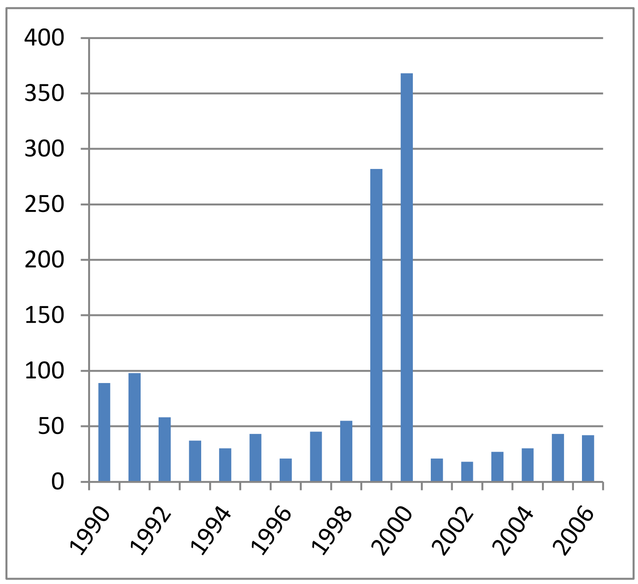

Figure 3. Number of stranded gray whales recorded along the west coast of North America between 1990 and 2006 (data from Brownell et al. 2007).

Gray whale calves were counted from Piedras Blancas, a shore site in central California, in 1980-81 (Poole 1984a) and each year since 1994 (Perryman *et al*. 2002, 2004, 2011). In 1980 and 1981, calves passing this site comprised 4.7% to 5.2% of the population (Poole 1984b). Estimates for the total number of northbound calves in 2001 to 2010 were 256, 842, 774, 1528, 945, 1020, 404, 553, 312 and 254, respectively (Perryman *et al*. 2011).

These calf estimates were highly variable between years. Calf production indices, as calculated by dividing the estimates of northbound calves by estimates of abundance for the population (Laake *et al*. 2009), ranged between 1.3 - 8.8% with a mean of 4.1% during the 17-year time series (1994-2010). Annual indices of calf production include impacts of early postnatal mortality but may overestimate recruitment because they exclude possibly significant levels of killer whale predation on gray whale calves north of the survey site. The relatively low reproductive output is consistent with reports of little or no population growth over the same time period (Laake *et al*. 2009; Punt and Wade 2010). Comparisons of sea ice cover in the Bering Sea with estimates of northbound calves revealed that average ice cover in the Bering Sea explains roughly 70% of the inter-annual variability in estimates of northbound calves the following spring (Perryman *et al*. 2011). In other words, a late retreat of seasonal ice may impact access to prey for pregnant females and reduce the probability that existing pregnancies will be carried to term.

Gray whale calves have also been counted from shore stations along the California coast during the southbound migration (Shelden *et al*. 2004). Those results have indicated significant increases in average annual calf counts near San Diego in the mid- to late-1970s compared to the 1950s and 1960s, and near Carmel in the mid-1980s through 2002 compared to late-1960s through 1980 (Shelden *et al*. 2004). This increase may be related to a trend toward later migrations over the observation period (Rugh *et al*. 2001, Buckland and Breiwick 2002), or it may be due to an increase in spatial and temporal distribution of calving as the population increased (Shelden *et al*. 2004).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for the ENP stock is calculated from Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1 + [CV(N)]^2)]^{½})$. Using the 2006/07 abundance estimate of 19,126 and its associated CV of 0.071, N_{MIN} for this stock is 18,017.

The minimum population estimate for PCFG gray whales is calculated as the lower 20th percentile of the log-normal distribution of the 2008 mark-recapture estimate given above, or 180 animals.

Current Population Trend

The population size of the ENP gray whale stock has been increasing over the past several decades despite an unusual mortality event in 1999 and 2000. The estimated annual rate of increase, based on the unrevised abundance estimates between 1967 and 1988, is 3.3% with a standard error of 0.44% (Buckland *et al*. 1993). Using the revised abundance time series from Laake *et al*. (2009) leads to an annual rate of increase for that same period of 3.2% with a standard error of 0.5% (Punt and Wade 2010).

Abundance estimates of PCFG gray whales reported by Calambokidis *et al*. (2010) from 1999 to 2008 indicate a stable population size over multiple spatial scales. No statistical analysis of trends in abundance is currently available for this population.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The abundance time-series has been revised (Laake *et al.* 2009), so estimates of productivity rates must be based on the revised time-series. Using abundance data through 2006/07, an analysis of the ENP gray whale population led to an estimate of R_{max} of 0.062, with a 90% probability the value was between 0.032 and 0.088 (Punt and Wade 2010). This estimate came from the best fitting age- and sex-structured model, which was a density-dependent Leslie model including an additional variance term, with females and males modeled separately, that accounted for the mortality event in 1999-2000. During review of a draft of this stock assessment report, the Pacific Scientific Review Group recommended using the R_{max} value of 0.062 reported by Punt and Wade (2010), instead of the lower 10th percentile of this estimate. This value of R_{max} is also applied to PCFG gray whales, as it is currently the best estimate of R_{max} available for gray whales in the Eastern North Pacific.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the ENP stock of gray whales is calculated as the minimum population size (18,017), <u>times</u> one-half of the maximum theoretical net population growth rate (½ x 6.2% = 3.1%), times a recovery factor of 1.0 for a stock above MNPL (Punt and Wade 2010), or 558 animals.

The potential biological removal (PBR) level for PCFG gray whales is calculated as the minimum population size (180 animals), <u>times</u> one half the maximum theoretical net population growth rate (½ x 6.2% = 3.1%), <u>times</u> a recovery factor of 0.5 (for a population of unknown status), resulting in a PBR of 2.8 animals.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

NMFS observers monitored the California/Oregon thresher shark/swordfish drift gillnet fishery from 2006 to 2010 and the California set gillnet halibut fishery in 2006, 2007, and 2010: no gray whales were observed entangled (Carretta and Enriquez 2007, 2009a, 2009b, 2010, 2012). Observers have not been assigned to most Alaska gillnet fisheries, including those in Bristol Bay known to interact with gray whales. Due to a lack of observer programs, mortality data from Canadian commercial fisheries is not available. Most data on human-caused mortality and serious injury of gray whales is from strandings (including at-sea reports of entangled animals alive or dead). Strandings represent only a fraction of actual gray whale deaths (natural or human-caused), as reported by Punt and Wade (2010), who estimated that only 3.9% to 13.0% of gray whales that die in a given year end up stranding and being reported.

A summary of human-caused mortality and serious injury resulting from unknown fishery sources (predominantly pot/trap or net fisheries) is given in Table 1 for the most recent 5-year period of 2006 to 2010. Total observed human-caused fishery mortality for ENP gray whales for the period 2006 to 2010 is 15 animals or 3.0 whales per year (Table 1). Total observed human-caused fishery mortality and serious injury for PCFG gray whales for the period 2006 to 2010 is one animal, or 0.2 whales per year (Table 1).

Table 1. Human-caused deaths and serious injuries (SI) of gray whales from fishery-related sources for the period 2006 to 2010 as recorded by NMFS stranding networks.

Date of observation	Location	PCFG range N 41- N 52 AND season?	Description	Determination
11-May-10	Orange County CA	No	Free-swimming animal entangled in gillnet; animal first observed inside Dana Point Harbor on 5/11/10; animal successfully disentangled on 5/12/10 & swam out of harbor; animal observed alive in surf zone for several hours on 5/14/10 off Doheny State Beach before washing up dead on beach	Dead
7-May-10	Cape Foulweather OR	No	Entangled in 3 crab pots, whale not relocated	SI
16-Apr-10	Seaside OR	No	27-ft long gray whale stranded dead, entangled in crab pot gear	Dead
8-Apr-10	San Francisco CA	No	Rope wrapped around caudal peduncle; identified as gray whale from photo. Free-swimming, diving. No rescue effort, no resightings, final status unknown	SI
5-Mar-10	San Diego	No	Free-swimming entangled whale reported by member of the public; no rescue effort initiated; no resightings reported; final status unknown	SI
21-Jul-09	Trinidad Head CA	Yes	Free-swimming animal with green gillnet, rope & small black floats wrapped around caudal peduncle; report received via HSU researcher on scene during research cruise; animal resighted on 3 Aug; no rescue effort initiated; final status unknown	SI
25-Mar-09	Seal Beach CA	No	Free-swimming animal with pink gillnet wrapped around head, trailing 4 feet of visible netting; report received via naturalist on local whale watch vessel; no rescue effort initiated; final status unknown	SI
31-Jan-09	San Diego CA	No	Free-swimming animal towing unidentified pot/trap gear; report received via USCG on scene; USCG reported gear as 4 lobster pots; final status unknown	SI
16-Apr-08	Eel River CA	No	Observed 12 miles west of Eel River by Humboldt State University personnel. It was unknown sexwith an estimated length of 20 ft and in emaciated condition. The animal was described as towing 40-50 feet of line & 3 crab pot buoys from the caudal peduncle and moving very slowly. Vessel retrieved the buoys, pulled them and ~20 ft of line onto the deck and cut it loose from the whale. The whale swam away slowly with 20-30 feet of line still entangling the peduncle, outcome unknown. Identification numbers on buoy traced to crab pot fishery gear that was last fished in Bering Sea in December 2007.	SI
26-Jul-07	Seattle WA	No[1]	Some gear was removed from the animal, swam away with gear still attached, tribal fishing nets, animal was not sighted again to remove	SI

[1]For purposes of calculating annual human-caused mortality, this whale is counted as an ENP whale and not part of the PCFG. This determination is based on observations that PCFG whales are not known to enter Puget Sound and current estimates of PCFG population size exclude whales seen in this area (J. Calambokidis, Cascadia Research, personal communication).

			more gear.	
20-Apr-07	Newport OR	No	Entangled in crab gear. skipper of nearby vessel removed 8 pots before he had to return to port due to darkness whale still had 8 buoys and several wraps of line around mid-section, left pectoral flipper, and through mouth	SI
13-Jul-06	Ekuk, AK	No	Stranded animal at Etolin Pt. Observed in commercial salmon set net.	Dead
3-Jul-06	Bristol Bay, AK	No	Animal trailing gear, able to swim but not dive. Ropes, buoys, and single line with buoys reported around mid-section.	SI
29-May-06	Gray's Harbor WA	No	Entangled in crab pot. Rope wrapped around fluke, tailstock, mid-body and through baleen. Rope scarring on head and left side (right side unseen).	Dead
14-May-06	Lakeside OR	No	Live entangled gray whale calf with crab pot and gear wrapped around tail stock and mouth, died on 5/15	Dead
23-Apr-06	Cape Lookout OR	No	Entangled whale close to shore, was behind two other larger whales; whale had netting over snout and long line (8-10 times its body length) and 2 bright orange floats	SI

Subsistence/Native Harvest Information

Subsistence hunters in Russia and the United States have traditionally harvested whales from the ENP stock in the Bering Sea, although only the Russian hunt has persisted in recent years (Reeves 2002). The Makah Tribe of Washington State traditionally hunted gray whales for at least several hundred years until the early 20th century (Huelsbeck 1988) and has requested authorization from NOAA/NMFS, under the MMPA and the Whaling Convention Act, to resume limited hunting of gray whales(see details in Stock Definition and Geographic Range section of this report). In2007, the IWC approved a 5-year quota (2008-2012) of 620 gray whales, with an annual cap of 140, for Russian and U.S. (Makah Indian Tribe) aboriginals based on the aboriginal needs statements from each country. The U.S. and Russia have agreed that the quota will be shared with an average annual harvest of 120 whales by the Russian Chukotka people and 4 whales by the Makah Indian Tribe. Total takes by the Russian hunt were 129 in 2006 (IWC 2008),126 in 2007 (IWC 2009), 127 in 2008 (IWC 2010), 115 in 2009 (IWC 2011c) and 118 in 2010 (IWC 2011a). Based on this information, the annual subsistence take averaged 123 whales during the 5-year period from 2006 to2010.

Other Mortality

Ship strikes are a source of mortality for gray whales (Table 2). For the most recent five-year period, 2006-2010, the total serious injury and mortality of ENP gray whales attributed to ship strikes is 11 animals, or 2.2 whales per year (Table 2). The total serious injury and mortality of PCFG gray whales during this same period is one animal, or 0.2 whales per year (Table 2). Additional mortality from ship strikes probably goes unreported because the whales either do not strand or do not have obvious signs of trauma.

In February 2010, a gray whale stranded dead near Humboldt, CA with parts of two harpoons embedded in the body. Since this whale was likely harpooned during the aboriginal hunt in Russian waters, it would have been counted as "struck and lost" in the harvest data.

One PCFG gray whale was illegally killed by hunters in Neah Bay in September 2007(Calambokidis *et al*. 2009).

Table 2. Summary of gray whale serious injuries (SI) and deaths attributed to vessel strikes for the five-year period 2006-2010.

Date of observation	Location	PCFG range N 41 - N 52 AND season?	Description	Determination
12-Mar-10	Santa Barbara CA	No	21 meter sailboat underway at 13 kts collided with free-swimming animal; whale breached shortly after collision; no blood observed in water; minor damage to lower portion of boat's keel; final status unknown; dna analysis of skin sample confirmed species as gray whale	SI
16-Feb-10	San Diego CA	No	Free-swimming animal with propeller-like wounds to dorsum	SI
9-Sep-09	Quileute River WA	Yes	USCG vessel reported to be traveling at 10 knots when they hit the gray whale at noon on 9/9/2009. The animal was hit with the prop and was reported alive after being hit, blood observed in water.	SI
1-May-09	Los Angeles CA	No	Catalina island transport vessel collided with free-swimming calf accompanied by adult animal; calf was submerged at time of collision; pieces of flesh & blood observed in water; calf never surfaced; presumed mortality	SI

27-Apr-09	Whidbey Is. WA	No	Large amount of blood in body cavity, bruising in some areas of blubber layer and in some internal organs. Findings suggestive of blunt force trauma likely caused by collision with a large ship.	Dead
5-Apr-09	Sunset Beach CA	No	Dead stranding; 3 deep propeller-like cuts on right side, just anterior of genital opening; carcass towed out to sea	Dead
4-Apr-09	Ilwaco WA	No	Necropsied, broken bones in skull; extensive hemorrhage head and thorax; sub-adult male	Dead
1-Mar-08	Mexico	No	Carcass brought into port on bow of cruise ship; collision occurred betweeen ports of San Diego and Cabo San Lucas between 5:00 p.m. On 2/28 & 7:20 a.m. On 3/1	Dead
7-Feb-08	Orange County CA	No	Carcass; propeller-like wounds to left dorsum from mid-body to caudal peduncle; deep external bruising on right side of head; field necropsy revealed multiple cranial fractures	Dead
1-Jun-07	Marin, CA	No	Carcass; 4 propeller-like wounds to body	Dead
20-Apr-06	San Francisco CA	No	Floating carcass; propeller wounds; killer whale rake mark scars	Dead
24-Mar-06	San Diego CA	No	Free-swimming animal struck by 18 foot pleasure craft; blood observed in water; final status of animal unknown	SI

HABITAT CONCERNS

Evidence indicates that the Arctic climate is changing significantly, resulting in a reduction in the extent of sea ice cover in some regions (Johannessen et al. 2004). These changes are likely to affect gray whales due to the impacts on the species' benthic food supply. With the increase in numbers of gray whales (Rugh et al. 2005), in combination with changes in prey distribution (Grebmeier et al. 2006; Moore et al. 2007), some gray whales have moved into new feeding areas, spreading their summer range (Rugh et al. 2001). Moore and Huntington (2008) observed that gray whales are opportunistic foragers, with documented feeding year-round off Kodiak, Alaska. Bluhm and Gradinger (2008) examined the availability of pelagic and benthic prey in the Arctic and concluded that pelagic prey is likely to increase while benthic prey is likely to decrease in response to climate change. They noted that marine mammal species that exhibit trophic plasticity (such as gray whales which feed on both benthic and pelagic prey) will adapt better than trophic specialists.

Global climate change is also likely to increase human activity in the Arctic as sea ice decreases, including oil and gas exploration and shipping (Hovelsrud et al. 2008). Such activity will increase the chance of oil spills and ship strikes in this region. Gray whales have demonstrated avoidance behavior to anthropogenic sounds associated with oil and gas exploration (Malme et al. 1983, 1984) and low-frequency active sonar during acoustic playback experiments (Buck and Tyack 2000, Tyack 2009).

Ocean acidification could reduce the abundance of shell-forming organisms (Fabry et al. 2008, Hall-Spencer et al. 2008), many of which are important in the gray whales' diet (Nerini 1984, Moore and Huntington 2008).

STATUS OF STOCK

In 1994, the ENP stock of gray whales was removed from the List of Endangered and Threatened Wildlife (the List), as it was no longer considered endangered or threatened under the Endangered Species Act (ESA) (NMFS 1994). Punt and Wade (2010) estimated the ENP population was at 91% of carrying capacity (K) and at 129% of the maximum net productivity level (MNPL), with a probability of 0.884 that the population is above MNPL and therefore within the range of its optimum sustainable population (OSP).

Even though the stock is within OSP, abundance will fluctuate as the population adjusts to natural and human-caused factors affecting carrying capacity of the environment (Rugh et al. 2005). It is expected that a population close to or at carrying capacity will be more susceptible to environmental fluctuations (Moore et al. 2001). The correlation between gray whale calf production and environmental conditions in the Bering Sea (Perryman et al. 2002) may reflect this. Overall, the population nearly doubled in size over the first 20 years of monitoring, and has fluctuated for the last 30 years around its average carrying capacity. This is consistent with a population approaching K.

Alter et al. (2007) used estimates of genetic diversity to infer that North Pacific gray whales may have numbered ~96,000 animals in both the western and eastern populations 1,100-1,600 years ago. The authors recommend that because the current estimate of the eastern stock of gray whales is at most 28-56% of this historic abundance, the stock should be designated as "depleted" under the MMPA. NMFS does not accept the recommendation made by Alter et al. (2007) for the following reasons. First, their analysis examines the historic population of the entire Pacific population of gray whales, while MMPA management occurs at the level of a stock, which in this case is the ENP stock. It is speculative to try to determine what proportion of the estimated abundance may have been in the eastern or western populations. It is also uncertain if Alter et al.'s estimates include the Atlantic population (Palsbøll et al. 2007). Second, NMFS relies on current carrying capacity in making MMPA determinations. Ecosystems change over time and with those changes, the carrying capacity of the ecosystem also changes. NMFS interprets carrying capacity to mean "current" carrying capacity in part because it is not reasonable to expect ecosystems to remain static over thousands of years. Thus, an estimate of stock abundance 1,100-1,600 years ago is not relevant to MMPA decision-making, even if such an estimate were available.

Based on 2006-2010 data, the estimated annual level of human-caused mortality and serious injury for ENP gray whales includes Russian harvest (123), mortality from commercial fisheries (3.0), and ship strikes (2.2), totals 128 whales per year, which does not exceed the PBR (558). Therefore, the ENP stock of gray whales is not classified as a strategic stock.

PCFG gray whales do not currently have a formal status under the MMPA, though the population size appears stable, based on photo-ID studies (IWC 2011a; IWC 2011b). Total annual human-caused mortality of PCFG gray whales during the period 2006 to 2010 includes deaths due to commercial fisheries (0.2/yr), ship strikes (0.2/yr), and illegal hunts (0.2/yr), or 0.6 whales annually. This does not exceed the PBR level of 2.8 whales for this population. Levels of human-caused mortality and serious injury resulting from commercial fisheries and ship strikes for both ENP and PCFG whales represent minimum estimates as recorded by stranding networks or at-sea sightings.

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doi:10.7289/V5/TM-SWFSC-549

NOAA Technical Memorandum NMFS

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AUGUST 2015

U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENTS: 2014

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NOAA-TM-NMFS-SWFSC-549

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The National Oceanic and Atmospheric Administration (NOAA), organized in 1970, has evolved into an agency that establishes national policies and manages and conserves our oceanic, coastal, and atmospheric resources. An organizational element within NOAA, the Office of Fisheries, is responsible for fisheries policy and the direction of the National Marine Fisheries Service (NMFS).

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SWFSC Technical Memorandums are accessible online at the SWFSC web site (http//swfsc.noaa.gov). Print copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151 (http://www.ntis.gov).

Stock assessment reports and appendices revised in 2014 are highlighted and underlined; all others will be reprinted as they appear in the 2013 Pacific Region Stock Assessment Reports (Carretta *et al.* 2014).

PINNIPEDS

CETACEANS - U.S. WEST COAST

CETACEANS – HAWAII & WESTERN PACIFIC

APPENDICES

PREFACE

Under the 1994 amendments to the Marine Mammal Protection Act (MMPA), the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) are required to publish Stock Assessment Reports for all stocks of marine mammals within U.S. waters, to review new information every year for strategic stocks and every three years for non-strategic stocks, and to update the stock assessment reports when significant new information becomes available.

Pacific region stock assessments include those studied by the Southwest Fisheries Science Center (SWFSC, La Jolla, CA), the Pacific Islands Fisheries Science Center (PIFSC, Honolulu, HI), the National Marine Mammal Laboratory (NMML, Seattle, WA), and the Northwest Fisheries Science Center (NWFSC, Seattle, WA).

The 2014 Pacific marine mammal stock assessments include revised reports for 11 Pacific marine mammal stocks under NMFS jurisdiction, including six "strategic" stocks: Hawaiian monk seal, Southern Resident killer whale, Main Hawaiian Islands Insular false killer whale, Hawaii Pelagic false killer whale, California/Oregon/Washington sperm whale, and Western North Pacific gray whale. New abundance estimates are available for three stocks in the Pacific Islands region and five U.S. west coast stocks. New estimates of abundance for the California/Oregon/Washington stock of sperm whales are based on a Bayesian trend analysis that utilizes previously collected line-transect data (Moore and Barlow, 2014), resulting in a more stable time series of abundance estimates. Mortality and serious injury estimates of California/Oregon/Washington sperm whales in California drift gillnets are updated, based on pooling additional years of data (>5 years) to reduce bias and improve precision in mean annual bycatch estimates (Carretta and Moore 2014). The combination of new abundance estimates and pooling of bycatch estimates over a longer time period for this stock of sperm whales results in mean annual bycatch estimates that no longer exceed PBR. In addition, a new stock assessment report for Western North Pacific gray whales is presented for the first time, prompted by new data showing that gray whales previously photographed in the western North Pacific utilize U.S. and Mexican waters. Stock Assessments for Alaska region marine mammals are published by the National Marine Mammal Laboratory (NMML) in a separate report.

This is a working document and individual stock assessment reports will be updated as new information on marine mammal stocks and fisheries becomes available. Background information and guidelines for preparing stock assessment reports are reviewed in Wade and Angliss (1997). The authors solicit any new information or comments which would improve future stock assessment reports.

Draft versions of the 2014 stock assessment reports were reviewed by the Pacific Scientific Review Group at the April 2014 meeting.

These Stock Assessment Reports summarize information from a wide range of original data sources and an extensive bibliography of all sources is given in each report. We recommend users of this document refer to and cite *original literature sources* referenced within the stock assessment reports rather than citing this report or previous Stock Assessment Reports.

Suggested citation for this report:

Carretta, J.V., E.M. Oleson, D.W. Weller, A.R. Lang, K.A. Forney, J. Baker, M.M. Muto, B. Hanson, A.J. Orr, H. Huber, M.S. Lowry, J. Barlow, J.E. Moore, D. Lynch, L. Carswell, and R.L. Brownell Jr. 2015. U.S. Pacific Marine Mammal Stock Assessments: 2014. U.S. Department of Commerce, NOAA Technical Memorandum, NOAA-TM-NMFS-SWFSC-549. 414 p.

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GRAY WHALE (*Eschrichtius robustus*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Once common throughout the Northern Hemisphere, the gray whale was extinct in the Atlantic by the early 1700s (Fraser 1970; Mead and Mitchell 1984), though one anomalous sighting occurred in the Mediterranean Sea in 2010 (Scheinin *et al*. 2011) and another off Namibia in 2013 (Elwen and Gridley 2013). Gray whales are now only commonly found in the North Pacific. Genetic comparisons indicate there are distinct "Eastern North Pacific" (ENP) and "Western North Pacific" (WNP) population stocks, with differentiation in both mtDNA haplotype and microsatellite allele frequencies (LeDuc et al. 2002; Lang et al. 2011a; Weller et al. 2013).

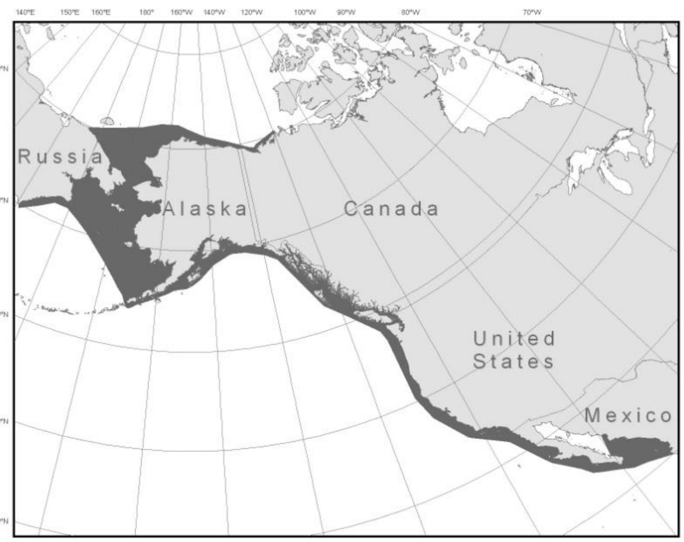

Figure 1. Approximate distribution of the Eastern North Pacific stock of gray whales (shaded area).

During summer and fall, most whales in the ENP population feed in the Chukchi, Beaufort and northwestern Bering Seas (Fig. 1). An exception to this is the relatively small number of whales (approximately 200) that summer and feed along the Pacific coast between Kodiak Island, Alaska and northern California (Darling 1984, Gosho *et al.* 2011, Calambokidis *et al.* 2012), referred to as the "Pacific Coast Feeding Group" (PCFG). Three primary wintering lagoons in Baja California, Mexico are utilized, and some females are known to make repeated returns to specific lagoons (Jones 1990). Genetic substructure on the wintering grounds is indicated by significant differences in mtDNA haplotype frequencies between females (mothers with calves) using two of the primary calving lagoons and females sampled in other areas (Goerlitz *et al*. 2003). Other research identified a small, but significant departure from panmixia between two of the lagoons using nuclear data, although no significant differences were identified using mtDNA (Alter *et al.* 2009).

Tagging, photo-identification and genetic studies show that some whales identified in the WNP off Russia have been observed in the ENP, including coastal waters of Canada, the U.S. and Mexico (Lang 2010; Mate et al. 2011; Weller et al. 2012; Urbán et al. 2013, Mate et al. 2015). In combination, these studies have recorded a total of 27 gray whales observed in both the WNP and ENP. Despite this overlap, significant mtDNA and nDNA differences are found between whales in the WNP and those summering in the ENP (Lang *et al*. 2011a).

In 2010, the IWC Standing Working Group on Aboriginal Whaling Management Procedure noted that different names had been used to refer to gray whales feeding along the Pacific coast, and agreed to designate animals that spend the summer and autumn feeding in coastal waters of the Pacific coast of North America from California to southeast Alaska as the "Pacific Coast Feeding Group" or PCFG (IWC 2012). This definition was further refined for purposes of abundance estimation, limiting the geographic range to the area from northern California to northern British Columbia (from 41°N to 52°N), limiting the temporal range to the period from June 1 to November 30, and counting only those whales seen in more than one year within this geographic and temporal range (IWC 2012). The IWC adopted this definition in 2011, but noted that "not all whales seen within the PCFG area at this time will be PCFG whales and some PCFG whales will be found outside of the PCFG area at various times during the year." (IWC 2012).

Photo-identification studies between northern California and northern British Columbia provide data on the abundance and population structure of PCFG whales (Calambokidis *et al*. 2012). Gray whales using the study area in summer and autumn include two components: **1)** whales that frequently return to the area, display a high degree of intra-seasonal " fidelity" and account for a majority of the sightings between 1 June and 30 November. Despite movement and interchange among sub-regions of the study area, some whales are more likely to return to the same sub-region where they were observed in previous years; **2)**"visitors" from the northbound migration that are sighted only in one year, tend to be seen for shorter time periods in that year, and are encountered in more limited areas. Photo-identification (Gosho *et al*. 2011; Calambokidis *et al*. 2012) and satellite tagging (Mate *et al*. 2010; Ford *et al.*

2012) studies have documented some PCFG whales off Kodiak Island, the Gulf of Alaska and Barrow, Alaska, well to the north of the pre-defined 41°N to 52°N boundaries used in some PCFG-related analyses (e.g. abundance estimation).

Frasier *et al.* (2011) found significant differences in mtDNA haplotype distributions between PCFG and ENP gray whale sequences, in addition to differences in long-term effective population size, and concluded that the PCFG qualifies as a separate management unit under the criteria of Moritz (1994) and Palsbøll *et al.* (2007). The authors noted that PCFG whales probably mate with the rest of the ENP population and that their findings were the result of maternally-directed site fidelity of whales to different feeding grounds.

Lang *et al.* (2011b) assessed stock structure of ENP whales from different feeding grounds using both mtDNA and eight microsatellite markers. Significant mtDNA differentiation was found when samples from individuals (n=71) sighted over two or more years within the seasonal range of the PCFG were compared to samples from whales feeding north of the Aleutians (n=103), and when PCFG samples were compared to samples collected off Chukotka, Russia (n=71). No significant differences were found when these same comparisons were made using microsatellite data. The authors concluded that (1) the significant differences in mtDNA haplotype frequencies between the PCFG and whales sampled in northern areas indicates that use of some feeding areas is being influenced by internal recruitment (e.g., matrilineal fidelity), and (2) the lack of significance in nuclear comparisons suggests that individuals from different feeding grounds may interbreed. The level of mtDNA differentiation identified, while statistically significant, was low and the mtDNA haplotype diversity found within the PCFG was similar to that found in the northern strata. Lang *et al*. (2011b) suggested this could indicate recent colonization of the PCFG but could also be consistent with external recruitment into the PCFG. An additional comparison of whales sampled off Vancouver Island, British Columbia (representing the PCFG) and whales sampled at the calving lagoon at San Ignacio also found no significant differences in microsatellite allele frequencies, providing further support for interbreeding between the PCFG and the rest of the ENP stock (D'Intino et al. 2012). Lang and Martien (2012) investigated potential immigration levels into the PCFG using simulations and produced results consistent with the empirical (mtDNA) analyses of Lang et al. (2011b). Simulations indicated that immigration of >1 and <10 animals per year into the PCFG was plausible, and that annual immigration of 4 animals/year produced results most consistent with the empirical study.

While the PCFG is recognized as a distinct feeding aggregation (Calambokidis et al. 2012; Mate et al. 2010; Frasier et al. 2011; Lang et al. 2011b; IWC 2012), the status of the PCFG as a population stock remains unresolved (Weller et al. 2013). A NMFS gray whale stock identification workshop held in 2012 included a review of available photo-identification, genetic, and satellite tag data. The report of the workshop states "there remains a substantial level of uncertainty in the strength of the lines of evidence supporting demographic independence of the PCFG." (Weller et al. 2013). The NMFS task force, charged with evaluating stock status of the PCFG, noted that "both the photo-identification and genetics data indicate that the levels of internal versus external recruitment are comparable, but these are not quantified well enough to determine if the population dynamics of the PCFG are more a consequence of births and deaths within the group (internal dynamics) rather than related to immigration and/or emigration (external dynamics)." Further, given the lack of significant differences found in nuclear DNA markers between PCFG whales and other ENP whales, the task force found no evidence to suggest that PCFG whales breed exclusively or primarily with each other, but interbreed with ENP whales, including potentially other PCFG whales. Additional research is needed to better identify recruitment levels into the PCFG and further assess the stock status of PCFG whales (Weller et al. 2013). In contrast, the task force noted that WNP gray whales should be recognized as a population stock under the MMPA, and NMFS prepared a separate report for WNP gray whales in 2014. Because the PCFG appears to be a distinct feeding aggregation and may warrant consideration as a distinct stock in the future, separate PBRs are calculated for the PCFG to assess whether levels of human-caused mortality are likely to cause local depletion.

POPULATION SIZE

Systematic counts of gray whales migrating south along the central California coast have been conducted by shore-based observers at Granite Canyon most years since 1967 (Fig. 2). The most recent estimate of abundance for the ENP population is from the 2010/2011 southbound survey and is 20,990 (CV=0.05) whales (Durban *et al*. 2013) (Fig. 2).

Photographic mark-recapture abundance estimates for PCFG gray whales between 1998 and 2012, including estimates for a number of smaller geographic areas within the IWC-defined PCFG region (41°N to 52°N), are reported in Calambokidis *et al*. (2014). The 2012 abundance estimate for the defined range of the PCFG between 41°N to 52°N is 209 (SE=15.4; CV= 0.07).

Eastern North Pacific gray whales experienced an unusual mortality event (UME) in 1999 and 2000, when large numbers of emaciated animals stranded along the west coast of North America (Moore *et al*., 2001; Gulland *et al*., 2005). Over 60% of the dead whales were adults, compared with previous years when calf strandings were more common. Several factors following this UME suggest that the high mortality rate observed was a short-term, acute event and not a chronic situation or trend: 1) in 2001 and 2002, strandings decreased to levels below UME levels (Gulland *et al*., 2005); 2) average calf production returned to levels seen before 1999; and 3) in 2001, living whales no longer appeared emaciated. Oceanographic factors that limited food availability for gray whales were identified as likely causes of the UME (LeBouef et al. 2000; Moore et al. 2001; Minobe 2002; Gulland et al. 2005), with resulting declines in survival rates of adults during this period (Punt and Wade 2012). The population has recovered to levels seen prior to the UME of 1999-2000 (Fig. 2).

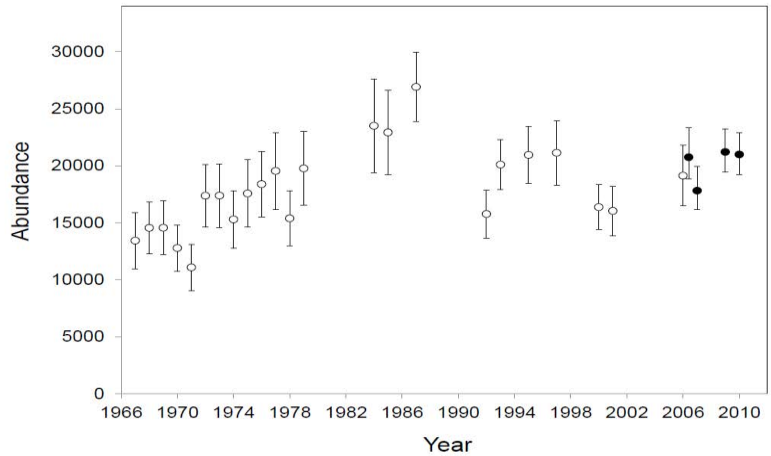

Figure 2. Estimated abundance of Eastern North Pacific gray whales from NMFS counts of migrating whales past Granite Canyon, California. Open circles represent abundance estimates and 95% confidence intervals reported by Laake et al. (2012). Closed circles represent estimates and 95% posterior highest density intervals reported by Durban et al. (2013) for the 2006/7, 2007/8, 2009/10, and 2010/11 migration seasons.

Gray whale calves have been counted from Piedras Blancas, a shore site in central California, in 1980-81 (Poole 1984a) and each year from 1994 to 2012 (Perryman *et al*. 2002; Perryman and Weller 2012). In 1980 and 1981, calves comprised 4.7% to 5.2% of the population (Poole 1984b). Calf production indices, as calculated by dividing northbound calf estimates by estimates of population abundance (Laake *et al*. 2012), ranged between 1.3 - 8.8% (mean=4.2%) during 1994-2012. Annual indices of calf production include impacts of early postnatal mortality but may overestimate recruitment because they exclude possibly significant levels of killer whale predation on gray whale calves north of the survey site (Barrett-Lennard et al. 2011). The relatively low reproductive output reported is consistent with little or no population growth over the time period (Laake *et al*. 2012; Punt and Wade 2012).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for the ENP stock is calculated from Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the 2010/11 abundance estimate of 20,990 and its associated CV of 0.05 (Durban et al. 2013), N_{MIN} for this stock is 20,125.

The minimum population estimate for PCFG gray whales is calculated as the lower 20th percentile of the log-normal distribution of the 2012 mark-recapture estimate of 209 (CV=0.07), or 197 animals.

Current Population Trend

The population size of the ENP gray whale stock has increased over several decades despite an UME in 1999 and 2000 and has been relatively stable since the mid-1990s (see Fig. 2).

Abundance estimates of PCFG gray whales reported by Calambokidis et al. (2014) show a high rate of increase in the late 1990s and early 2000s, but have been relatively stable since 2003.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Using abundance data through 2006/07, an analysis of the ENP gray whale population led to an estimate of R_{max} of 0.062, with a 90% probability the value was between 0.032 and 0.088 (Punt and Wade 2012). This value of R_{max} is also applied to PCFG gray whales, as it is currently the best estimate of R_{max} available for gray whales in the ENP.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the ENP stock of gray whales is calculated as the minimum population size (20,125), times one-half of the maximum theoretical net population growth rate (½ x 6.2% = 3.1%), times a recovery factor of 1.0 for a stock above MNPL (Punt and Wade 2012), or 624 animals per year.

The potential biological removal (PBR) level for PCFG gray whales is calculated as the minimum population size (197 animals), times one half the maximum theoretical net population growth rate (½ x 6.2% = 3.1%), times a recovery factor of 0.5 (for a population of unknown status), resulting in a PBR of 3.1 animals per year. Use of the recovery factor of 0.5 for PCFG gray whales, rather than 1.0 used for ENP gray whales, is based on uncertainty regarding stock structure (Weller et al. 2013) and guidelines for preparing marine mammal stock assessments which state that "Recovery factors of 1.0 for stocks of unknown status should be reserved for cases where there is assurance that N_{min}, R_{max}, and the kill are unbiased and where the stock structure is unequivocal" (NMFS 2005). Given uncertainties in the levels of external versus internal recruitment of PCFG whales described above, the equivocal nature of the stock structure, and the small estimated population size of the PCFG, NMFS will continue to use the default recovery factor of 0.5 for PCFG gray whales.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Serious Injury Guidelines

NMFS uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases todistinguishserious from non-serious injury (Angliss and DeMaster 1998, Andersen *et al*. 2008, NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*".

Fisheries Information

No gray whales were observed entangled in California gillnet fisheries between 2008 and 2012 (Carretta and Enriquez 2009, 2010, 2012a, 2012b, Carretta *et al*., 2014a.), but previous mortality in the swordfish drift gillnet fishery has been observed (Carretta et al. 2004) and there have been recent sightings of free-swimming gray whales entangled in gillnets (Table 1). Alaska gillnet fisheries largely lack observer programs, including those in Bristol Bay known to interact with gray whales. Most data on human-caused mortality and serious injury of gray whales are from strandings, including at-sea reports of entangled animals alive or dead (Carretta et al. 2013, 2014b). Strandings represent only a fraction of actual gray whale deaths (natural or human-caused), as reported by Punt and Wade (2012), who estimated that only 3.9% to 13.0% of gray whales that die in a given year end up stranding and being reported.

A summary of human-caused mortality and serious injury resulting from unknown fishery and marine debris sources (mainly pot/trap or net fisheries) is given in Table 1 for the most recent 5-year period of 2008 to 2012. Total observed human-caused fishery mortality and serious injury for ENP gray whales is 22.25 animals (8 serious injuries, 8.25 prorated serious injuries, and 6 deaths), or 4.45 whales per year (Table 1). Total observed human-caused fishery mortality and serious injury for gray whales observed in the PCFG range and season for the period 2008 to 2012 is 0.75 animals (0.75 prorated serious injuries), or 0.15 whales per year (Table 1). Three gray whales from Table 1 (one death and two serious injuries) were detected in California waters during the known PCFG season, but were south of the area recognized by the IWC as the PCFG management area. It is possible that some of these whales could be PCFG whales, but no photographic identifications were available to establish their identity. They are included in ENP gray whale serious injury and death totals.

Table 1. Human-caused deaths and serious injuries (SI) of gray whales from fishery-related and marine debris sources for the period 2008 to 2012 as recorded by NMFS stranding networks and observer programs.

Date of observation	Location	PCFG range N 41- N 52 AND season?	Description	Determination (SI Prorate value)
13-Oct-2012	Fort Bragg, CA	No	Entangled animal report; animal reported with rope around the peduncle which wasn't seen in photographs but photos did show green gillnet with cuts to the head; animal disappeared and final status is unknown.	SI
31-Aug-2012	Los Angeles, CA	No	Animal first detected near San Diego. Subadult gray whale reported entangled with small gauge, dark-colored line deeply embedded around its tail stock. Little gear trails. Entanglement was once more involved as indicated by scars on the animal's body. Animal in very poor condition - emaciated, scarred and a heavy load of cyamid	Dead

			amphipods. Black line around peduncle, 20 ft trailing; observed off san San Diego on 8/31, completely disentangled off L.A. 9/6, stranded dead 9/14/12.	
22-Aug-2012	Prince William Sound, AK	No	Whale sighted by tour boat. Few details, other than part of a fishing net was observed being trailed from a gray whale's fin. Photos apparently available, but have not been located. Prince william William Sound. Extent and severity of entanglement unknown.	SI (0.75)
16-Jun-2012	Prince William Sound, AK	No	30' gray whale in prince william Prince William Sound entangled in gear. Thrashing at surface and moving at 4-5 knots. No wounds or chafing was observed. Gillnet, corkline (at least 12 floats), and leadline observed over animal's rostrum, body, and tailstock. Both pectoral flippers appeared pinned to body. Animal later appeared tired and was swimming at 2 knots. It was not relocated. Assigned serious injury because gear appears to be constricting movement of whale's flippers.	SI
13-May-2012	Monterey, CA	No	Animal entangled through mouth in at least two sets of suspected pot gear that that hang below. Animal anchored with a short scope in 28 feet of water to suspected pots. Bundle of gear, including 4 buoys lie under animal. Animal having some difficulty getting to surface. Animal eventually disentangled, but results of entanglement may still be life-threatening.	SI
8-May-2012	Eureka, CA	No	Entangled animal report; deep cuts from rope around peduncle and lacerations at fluke notch and lateral edge of fluke; successfully disentangled but long-term survival noted as questionable. Gear was collected and identified as Dungeness crab pot gear. Animal entirely freed of gear. Animal in fair condition and slightly emaciated. Deep cuts (~ 2 inches) from the rope around the peduncle remained. Gear was recovered. Results of entanglement may still be life threatening.	SI
5-May-2012	Monterey, CA	No	Whale watch vessel noticed from images taken of a 20 - 25 foot gray whale they had been observing earlier in the day, that animal was actually entangled. A small gauge line, likely from right side of mouth goes over the animal's back, and over blowholes, to left side of mouth. No buoys or trailing line were observed. Animal in fair condition. Animal sighted next day by whale watch vessel. Confirmed mouth entanglement, appears to be strapping material.	SI (0.75)
28-Apr-2012	Fort Bragg, CA	No	Small gray whale off fort bragg Fort Bragg, CA, in company of two other animals, trailing two buoys.	SI (0.75)
21-Apr-2012	San Simeon, CA	No	Rope like marks on caudal peduncle. Rope impression on pectoral fin. Photos taken.	Dead
17-Apr-2012	Laguna Beach, CA	No	40-foot gray whale reported entangled with approximately 150 feet of line trailing. Four spongex bullet buoys lie along the left side of the animal. Entanglement involves the mouth, a wrap over the head, and the left pectoral flipper. Entanglement appears recent. Partially disentangled on 5/3/12 by fishermen.	SI (0.75)
24-Mar-2012	San Diego, CA	No	Entangled animal report; gillnet gear around peduncle; response effort resulted in successful disentanglement with >100 ft of pink gillnet removed from animal, but animal subsequently observed dead on 03/27 (floating, skin sample taken, no necropsy). Net removed on 03/24 found to contain one dead ca sea lion and three dead sharks.	Dead
28-Jan-2012	San Diego, CA	No	Entangled animal report; towing two orange buoys and at least 150 feet of line; unknown fishery, reported as possible gillnet; no response effort.	SI (0.75)
17-Jan-2012	Unimak Pass, AK	No	A 40' whale was caught in cod pot gear near Unimak Pass. Lines were cut by boat crew and buoys were recovered, however, the pot and some line remained in the water. Any line possibly remaining on animal thought to be minimal. Gray whale species determination made following extensive questioning by local biologist. Determination: prorated serious injury because gear possibly remains on animal.	SI (0.75)
25-Aug-2011	San Mateo, CA	No	One white "crab pot" buoy next to body by left pectoral fin; float stayed next to body and did not change position; animal remained in same position - possibly anchored; only observed for ~2 min; not resighted, no rescue, outcome unknown.	SI
12-Sep-2010	Central Bering Sea	No	Bering Sea / Aleutian Islands flatfish trawl fishery: 12 m animal caught in gear. Photos taken.	Dead
11-May-2010	Orange County CA	No	Free-swimming animal entangled in gillnet; animal first observed inside Dana Point Harbor on 5/11/10; animal successfully	Dead

			disentangled on 5/12/10 & swam out of harbor; animal observed alive in surf zone for several hours on 5/14/10 off Doheny State Beach before washing up dead on beach	
7-May-2010	Cape Foulweather OR	No	Entangled in 3 crab pots, whale not relocated.	SI (0.75)
16-Apr-2010	Seaside OR	No	27-ft long gray whale stranded dead, entangled in crab pot gear	Dead
8-Apr-2010	San Francisco CA	No	Rope wrapped around caudal peduncle; identified as gray whale from photo. Free-swimming, diving. No rescue effort, no resightings, final status unknown	SI
5-Mar-2010	San Diego	No	Free-swimming entangled whale reported by member of the public; no rescue effort initiated; no resightings reported; final status unknown.	SI (0.75)
21-Jul-2009	Trinidad Head CA	Yes	Free-swimming animal with green gillnet, rope & small black floats wrapped around caudal peduncle; report received via HSU researcher on scene during research cruise; animal resighted on 3 Aug; no rescue effort initiated. Photos show rope cutting into caudal peduncle. This whale was re-sighted in 2010 and 2011, still trailing gear. Whale was resighted in 2013 and had shed gear, and was apparently in good health (Jeff Jacobsen, pers. comm.).	NSI
24-Jun-2009	Clallam County, WA	Yes	Whale found entangled in tribal set gillnet in morning. Net had been set 8 pm previous day. Whale able to breath, but not swim freely and was stationary in net. Right pectoral flipper and head were well-wrapped in net webbing. In response to disentanglement attempts, whale reacted violently and swam away. The net was retrieved and found to be torn in two. No confirmation on whether whale was completely free of netting.	SI (0.75)
9-Apr-2009	Sitka, AK	No	Thick black line wrapped twice around whale's body posterior to the eyes was cut and pulled away by private citizen. Animal swam away and dove.	SI (0.75)
25-Mar-2009	Seal Beach CA	No	Free-swimming animal with pink gillnet wrapped around head, trailing 4 feet of visible netting; report received via naturalist on local whale watch vessel; no rescue effort initiated; final status unknown	SI (0.75)
31-Jan-2009	San Diego CA	No	Free-swimming animal towing unidentified pot/trap gear; report received via USCG on scene; USCG reported gear as 4 lobster pots; final status unknown	SI (0.75)
16-Apr-2008	Eel River CA	No	Observed 12 miles west of Eel River by Humboldt State University personnel. It was unknown sex, with an estimated length of 20 ft and in emaciated condition. The animal was described as towing 40-50 feet of line & 3 crab pot buoys from the caudal peduncle and moving very slowly. Vessel retrieved the buoys, pulled them and ~20 ft of line onto the deck and cut it loose from the whale. The whale swam away slowly with 20-30 feet of line still entangling the peduncle, outcome unknown. Identification numbers on buoy traced to crab pot fishery gear that was last fished in Bering Sea in December 2007.	SI

Subsistence/Native Harvest Information

Subsistence hunters in Russia and the United States have traditionally harvested whales from the ENP stock in the Bering Sea, although only the Russian hunt has persisted in recent years (Huelsbeck 1988; Reeves 2002). In 2005, the Makah Indian Tribe requested authorization from NOAA/NMFS, under the MMPA and the Whaling Convention Act, to resume limited hunting of gray whales for ceremonial and subsistence purposes in the coastal portion of their usual and accustomed (U&A) fishing grounds off Washington State (NMFS 2008). The spatial overlap of the Makah U&A and the summer distribution of PCFG whales has management implications. The proposal by the Makah Tribe includes time/area restrictions designed to reduce the probability of killing a PCFG whale and to focus the hunt on whales migrating to/from feeding areas to the north. The Makah proposal also includes catch limits for PCFG whales that result in the hunt being terminated if these limits are met. Also, observations of gray whales moving between the WNP and ENP highlight the need to estimate the probability of a gray whale observed in the WNP being taken during a hunt by the Makah Tribe (Moore and Weller 2013). NMFS has published a notice of intent to prepare an environmental impact statement (EIS) on the proposed hunt (NMFS 2012) and the IWC has evaluated the potential impacts of the proposed hunt and other sources of human-caused mortality on PCFG whales and concluded, with certain qualifications, that the proposed hunt meets the Commission's conservation objectives (IWC 2013). The Scientific Committee has not scheduled an implementation review of the impacts of the Makah hunt on whales using summering feeding areas in the WNP, but is continuing to investigate stock structure of north Pacific gray whales and may schedule such a review in the future (IWC 2013). In 2012, the IWC approved a 6-year quota (2013-2018) of 744 gray whales, with an annual cap of 140, for Russian and U.S. (Makah Indian Tribe) aboriginals based on the joint request and needs statements submitted by the U.S. and Russian federation. The U.S. and Russia have agreed that the quota will be shared with an average annual harvest of 120 whales by the Russian Chukotka people and 4 whales by the Makah Indian Tribe. Total takes by the Russian hunt during the past five years were: 130 in 2008,116 in 2009, 118 in 2010, 128 in 2011, and 143 in 2012 (source: http://iwc.int/table_aboriginal). Based on this information, the annual subsistence take averaged 127 whales during the 5-year period from 2008 to 2012.

Other Mortality

Ship strikes are a source of mortality for gray whales (Table 2). For the most recent five-year period, 2008-2012, the total serious injury and mortality of ENP gray whales attributed to ship strikes is 9.8 animals (including 7 deaths, 2 serious injuries, and 0.8 prorated serious injuries, or 2.0 whales per year (Table 2, Carretta et al. 2013, Carretta et al. 2014b.). The total ship strike serious injury and mortality of gray whales observed in the PCFG range and season during this same period is 0.52 animals, or 0.1 whales per year (Table 2). One gray whale ship strike in Table 2 was detected in California waters during the known PCFG season, but was south of the area recognized by the IWC as the PCFG management area. It is possible that this animal could be a PCFG whale, but no photographic identification was available to establish its identity. It is included in ENP gray whale serious injury and death totals. Additional mortality from ship strikes probably goes unreported because the whales either do not strand or do not have obvious signs of trauma.

In February 2010, a gray whale stranded dead near Humboldt, CA with parts of two harpoons embedded in the body. Since this whale was likely harpooned during the aboriginal hunt in Russian waters, it would have been counted as “struck and lost” in the harvest data.

HABITAT CONCERNS

Near shore industrialization and shipping congestion throughout the migratory corridors of the ENP gray whale stock represent risks by increasing the likelihood of exposure to pollutants and ship strikes, as well as a general degradation of the habitat.

Evidence indicates that the Arctic climate is changing significantly, resulting in a reductions in sea ice cover (Johannessen et al. 2004, Comiso et al. 2008). These changes are likely to affect gray whales. For example, the summer range of gray whales has greatly expanded in the past decade (Rugh et al. 2001). Bluhm and Gradinger (2008) examined the availability of pelagic and benthic prey in the Arctic and concluded that pelagic prey is likely to increase while benthic prey is likely to decrease in response to climate change. They noted that marine mammal species that exhibit trophic plasticity (such as gray whales which feed on both benthic and pelagic prey) will adapt better than trophic specialists.

Global climate change is also likely to increase human activity in the Arctic as sea ice decreases, including oil and gas exploration and shipping (Hovelsrud et al. 2008). Such activity will increase the chance of oil spills and ship strikes in this region. Gray whales have demonstrated avoidance behavior to anthropogenic sounds associated with oil and gas exploration (Malme et al. 1983, 1984) and low-frequency active sonar during acoustic playback experiments (Buck and Tyack 2000, Tyack 2009). Ocean acidification could reduce the abundance of shell-forming organisms (Fabry et al. 2008, Hall-Spencer et al. 2008), many of which are important in the gray whales’ diet (Nerini 1984).

Table 2. Summary of gray whale serious injuries (SI) and deaths attributed to vessel strikes for the five-year period 2008-2012. No vessel strikes were reported in 2012.

Date of observation	Location	PCFG range N 41 - N 52 AND season?	Description	Determination (SI prorate value)
6-Jun-2011	San Mateo CA	No	Massive hemorrhage into the thorax, blood clots around lungs. Lesions indicate massive trauma. Due to carcass position, the skeleton could not be completely examined (lying on back, top of skull in sand).	Dead
8-Apr-2011	San Francisco CA	No	Crushed mandible.	Dead
12-Feb-2011	Los Angeles CA	No	Private recreational vessel collided with free-swimming animal; animal breached just prior to contact, bouncing off side of vessel; dove immediately following contact & was not resighted; no blood observed in water; final status unknown; skin sample collected from vessel and genetically identified	SI (0.14)

			as a female gray whale. Vessel size assumed less than 65 ft and speed unknown.	
22-Jan-2011	San Diego CA	No	Pleasure sailboat collided with free-swimming animal; animal dove immediately following contact & was not resighted; no blood observed in water; final status unknown. Vessel size assumed less than 65 ft. And speed unknown.	SI (0.14)
12-Mar-2010	Santa Barbara CA	No	21 meter sailboat underway at 13 kts collided with free-swimming animal; whale breached shortly after collision; no blood observed in water; minor damage to lower portion of boat's keel; final status unknown; DNA analysis of skin sample confirmed species.	SI
16-Feb-2010	San Diego CA	No	Free-swimming animal with propeller-like wounds to dorsum.	SI (0.52)
9-Sep-2009	Quileute River WA	Yes	USCG vessel reported to be traveling at 10 knots when they hit the gray whale at noon on 9/9/2009. The animal was hit with the prop and was reported alive after being hit, blood observed in water.	SI (0.52)
1-May-2009	Los Angeles CA	No	Catalina island transport vessel collided with free-swimming calf accompanied by adult animal; calf was submerged at time of collision; pieces of flesh & blood observed in water; calf never surfaced; presumed mortality.	SI
27-Apr-2009	Whidbey Is. WA	No	Large amount of blood in body cavity, bruising in some areas of blubber layer and in some internal organs. Findings suggestive of blunt force trauma likely caused by collision with a large ship.	Dead
5-Apr-2009	Sunset Beach CA	No	Dead stranding; 3 deep propeller-like cuts on right side, just anterior of genital opening; carcass towed out to sea	Dead
4-Apr-2009	Ilwaco WA	No	Necropsied, broken bones in skull; extensive hemorrhage head and thorax; sub-adult male	Dead
1-Mar-2008	Mexico	No	Carcass brought into port on bow of cruise ship; collision occurred betweeen ports of San Diego and Cabo San Lucas between 5:00 p.m. On 2/28 & 7:20 a.m. On 3/1	Dead
7-Feb-2008	Orange County CA	No	Carcass; propeller-like wounds to left dorsum from mid-body to caudal peduncle; deep external bruising on right side of head; field necropsy revealed multiple cranial fractures	Dead

STATUS OF STOCK

In 1994, the ENP stock of gray whales was removed from the List of Endangered and Threatened Wildlife (the List), as it was no longer considered endangered or threatened under the Endangered Species Act (NMFS 1994). Punt and Wade (2012) estimated the ENP population was at 85% of carrying capacity (K) and at 129% of the maximum net productivity level (MNPL), with a probability of 0.884 that the population is above MNPL and therefore within the range of its optimum sustainable population (OSP).

Even though the stock is within OSP, abundance will fluctuate as the population adjusts to natural and human-caused factors affecting carrying capacity (Punt and Wade 2012). It is expected that a population close to or at carrying capacity will be more susceptible to environmental fluctuations (Moore et al. 2001). The correlation between gray whale calf production and environmental conditions in the Bering Sea may reflect this (Perryman et al. 2002; Perryman and Weller 2012). Overall, the population nearly doubled in size over the first 20 years of monitoring and has fluctuated for the last 30 years around its average carrying capacity. This is consistent with a population approaching K.

Based on 2008-2012 data, the estimated annual level of human-caused mortality and serious injury for ENP gray whales includes Russian harvest (127), mortality and serious injury from commercial fisheries (4.45), and ship strikes (2.0), totals 133 whales per year, which does not exceed the PBR (624). The IWC completed an implementation review for ENP gray whales (including the PCFG) in 2012 (IWC 2013) and concluded that harvest levels (including the proposed Makah hunt) and other human caused mortality are sustainable, given the current population abundance (Laake et al. 2012, Punt and Wade 2012). Therefore, the ENP stock of gray whales is not classified as a strategic stock.

PCFG gray whales do not currently have a formal status under the MMPA, though the population size appears to have been stable since 2003, based on photo-ID studies (Calambokidis et al. 2014, IWC 2012). Total annual human-caused mortality of PCFG gray whales during the period 2008 to 2012 includes deaths due to commercial fisheries (0.15/yr), and ship strikes (0.1/yr), or 0.25 whales annually. This does not exceed the PBR level of 3.1 whales for this population. Levels of human-caused mortality and serious injury resulting from commercial fisheries and ship strikes for both ENP and PCFG whales represent minimum estimates as recorded by stranding networks or at-sea sightings.

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GRAY WHALE (*Eschrichtius robustus*): Western North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Gray whales occur along the eastern and western margins of the North Pacific. In the western North Pacific (WNP), gray whales feed during summer and fall in the Okhotsk Sea off northeast Sakhalin Island, Russia, and off southeastern Kamchatka in the Bering Sea (Weller et al. 1999, 2002; Vertyankin et al. 2004; Tyurneva et al. 2010; Burdin et al. 2013; Figure 1). Some gray whales observed feeding off Sakhalin and Kamchatka migrate during the winter to the west coast of North America in the eastern North Pacific (Mate et al. 2011; Weller et al. 2012; Urbán *et al*. 2013), while others, including at least one whale first identified as a calf off Sakhalin, migrate to areas off Asia in the WNP (Weller et al. 2008; Weller et al. 2013a). Despite the observed movements between the WNP and eastern North Pacific (ENP), genetic comparisons show significant mitochondrial and nuclear genetic differences between whales sampled in the ENP and those sampled on the feeding ground off Sakhalin Island in the WNP (LeDuc et al. 2002; Lang et al. 2011). While a few previously unidentified non-calves are identified annually, a recent population assessment using photo-identification data from 1994 to 2011 fitted to an individually-based model found that whales feeding off Sakhalin Island have been demographically self-contained, at least in recent years, as new recruitment to the population is almost exclusively a result of calves born to mothers from within the group (Cooke et al. 2013).

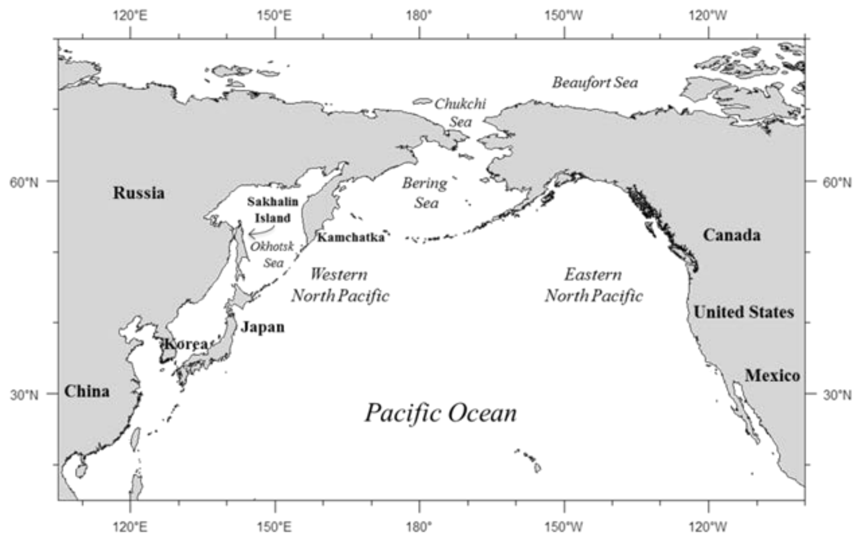

Figure 1. Range map of the Western North Pacific Stock of gray whales, including summering areas off Russia and wintering areas in the western and eastern Pacific.

Historical evidence indicates that the coastal waters of eastern Russia, the Korean Peninsula and Japan were once part of the migratory route in the WNP and that areas in the South China Sea may have been used as wintering grounds (Weller et al. 2002; Weller et al. 2013a). However, contemporary records of gray whales off Asia are rare, with only 13 from Japanese waters between 1990 and 2007 (Nambu *et al*. 2010) and 24 from Chinese waters since 1933 (Wang 1984; Zhu 2002). The last known record of a gray whale off Korea was in 1977 (Park 1995; Kim et al. 2013). While recent observations of gray whales off the coast of Asia are infrequent, they nevertheless continue to occur, including: (1) March/April 2014 - one or possibly two gray whales were sighted and photographed off the Shinano River in Teradomari (Niigata Prefecture) on the Sea of Japan coast of Honshu, Japan (Kato et al. 2014), (2) March 2012 - a gray whale was sighted and photographed in Mikawa Bay (Aichi Prefecture), on the Pacific coast of Honshu, Japan (Kato *et al*. 2012), and (3) November 2011 - a 13 m female gray whale was taken in fishing gear offshore of Baiqingxiang, China, in the Taiwan Strait (Zhu 2012).

Information from tagging, photo-identification and genetic studies show that some whales identified in the WNP off Russia have been observed in the ENP, including coastal waters of Canada, the U.S. and Mexico (Lang 2010; Mate et al. 2011; Weller et al. 2012; Urbán et al. 2013, Mate et al. 2015). In combination, these studies have recorded a total of 27 gray whales observed in both the WNP and ENP. Some whales that feed off Sakhalin Island in summer migrate east across the Pacific to the west coast of North America in winter, while others migrate south to waters off Japan and China. Taken together, these observations indicate that not all gray whales in the WNP share a common wintering ground (Weller et al. 2013a).

In 2012, the National Marine Fisheries Service convened a scientific task force to appraise the currently recognized and emerging stock structure of gray whales in the North Pacific (Weller et al. 2013b). The charge of the task force was to evaluate gray whale stock structure as defined under the Marine Mammal Protection Act (MMPA) and implemented through the National Marine Fisheries Service's Guidelines for Assessing Marine Mammal Stocks (GAMMS; NMFS 2005). Significant differences in both mitochondrial and nuclear DNA between whales sampled off Sakhalin Island (WNP) and whales sampled in the ENP provided convincing evidence that resulted in the task force advising that WNP gray whales should be recognized as a population stock under the MMPA and GAMMS guidelines. Given the interchange of some whales between the WNP and ENP, including seasonal occurrence of WNP whales in U.S. waters, the task force agreed that a stand-alone WNP gray whale population stock assessment report was warranted.

POPULATION SIZE

Photo-identification data collected between 1994 and 2011 on the gray whale summer feeding ground off Sakhalin Island in the WNP were used to calculate an abundance estimate of 140 (SE = ± 6, CV=0.043) whales for the age 1-plus (non-calf) population size in 2012 (Cooke et al. 2013). Some whales (approximately 70 individuals) sighted during the summer off southeastern Kamchatka have not been sighted off Sakhalin Island, but it is as yet unclear whether those whales are part of the WNP stock (IWC 2014).

Minimum Population Estimate

The minimum population estimate (N_{min}) for the WNP stock is calculated from Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{min} = N/\exp(0.842\times[\ln(1 +[CV(N)]^2)]^{½})$ and the abundance estimate of 140 (CV=0.043) whales from Cooke et al. (2013), resulting in a minimum population estimate of 135 gray whales on the summer feeding ground off Sakhalin Island in the WNP.

Current Population Trend

The WNP gray whale stock has increased over the last 10 years (2002-2012). The estimated realized average annual rate of population increase during this period is 3.3% per annum (± 0.5%) (Cooke et al. 2013).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

An analysis of the ENP gray whale population led to an estimate of R_{max} of 0.062, with a 90% probability the value was between 0.032 and 0.088 (Punt and Wade 2012). This value of R_{max} is also applied to WNP gray whales, as it is currently the best estimate of R_{max} available for any gray whale population.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (135), times one-half the estimated maximum annual growth rate for a gray whale population (½ of 6.2% for the Eastern North Pacific Stock, Punt and Wade 2012), times a recovery factor of 0.1 (for an endangered stock with N_{min} < 1,500, Taylor et al. 2003), and also multiplied by estimates for the proportion of the stock that uses U.S. EEZ waters (0.575) and the proportion of the year that those animals are in the U.S. EEZ (3 months, or 0.25 years) (Moore and Weller 2013), resulting in a PBR of 0.06 WNP gray whales per year, or approximately 1 whale every 17 years (if abundance and other parameters in the PBR equation remained constant over that time period).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Serious Injury Guidelines

NMFS uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to distinguis serious from non-serious injury (Angliss and DeMaster 1998, Andersen et al. 2008, NOAA 2012). NMFS defines serious injury as an "injury that is more likely than not to result in mortality".

Fisheries Information

The decline of gray whales in the WNP is attributable to commercial hunting off Korea and Japan between the 1890s and 1960s. The pre-exploitation abundance of WNP gray whales is unknown, but has been estimated to be between 1,500 and 10,000 individuals (Yablokov and Bogoslovskaya 1984). By 1910, after some commercial exploitation had already occurred, it is estimated that only 1,000 to 1,500 gray whales remained in the WNP population (Berzin and Vladimirov 1981). The basis for how these two estimates were derived, however, is not apparent (Weller et al. 2002). By the 1930s, gray whales in the WNP were considered by many to be extinct (Mizue 1951; Bowen 1974).

Today, a significant threat to gray whales in the WNP is incidental catches in coastal net fisheries (Weller et al. 2002; Kato et al. 2012; Weller et al. 2008; Weller et al. 2013a). Between 2005 and 2007, four female gray whales (including one mother-calf pair and one yearling) died in fishing nets on the Pacific coast of Japan. In addition, one adult female gray whale died as a result of a fisheries interaction in November 2011 off Pingtan County, China (Zhu 2012). An analysis of anthropogenic scarring of gray whales photographed off Sakhalin Island found that at least 18.7% (n=28) of 150 individuals identified between 1994 and 2005 had evidence of previous entanglements in fishing gear (Bradford et al. 2009), further highlighting the overall risks coastal fisheries pose to WNP gray whales.

In summer 2013, salmon net fishing was observed for the first time on the gray whale feeding ground off Sakhalin Island. Observations of whales within 100 m of salmon fishing nets have been made and a male gray whale was observed dragging fishing gear (rope), with a related injury on the caudal peduncle at the dorsal insertion point with the flukes (Weller et al. 2014).

Given that some WNP gray whales occur in U.S. waters, there is some probability of WNP gray whales being killed or injured by ship strikes or entangled in fishing gear within U.S. waters.

Subsistence/Native Harvest Information

In 2005, the Makah Indian Tribe requested authorization from NOAA/NMFS, under the Marine Mammal Protection Act of 1972 (MMPA) and the Whaling Convention Act, to resume limited hunting of gray whales for ceremonial and subsistence purposes in the coastal portion of their usual and accustomed (U&A) fishing grounds off Washington State (NOAA 2008). Observations of gray whales moving between the WNP and ENP highlight the need to estimate the probability of a gray whale observed in the WNP being taken during a hunt by the Makah Tribe (Moore and Weller 2013). Given conservation concerns for the WNP population, the Scientific Committee of the International Whaling Commission (IWC) emphasized the need to estimate the probability of a WNP gray whale being struck during aboriginal gray whale hunts (IWC 2012). Additionally, NOAA is required by the National Environmental Policy Act (NEPA) to prepare an Environmental Impact Statement (EIS) pertaining to the Makah's request. The EIS needs to address the likelihood of a WNP whale being taken during the proposed Makah gray whale hunt.

To estimate the probability that a WNP whale might be taken during the proposed Makah gray whale hunt, four alternative models were evaluated. These models made different assumptions about the proportion of WNP whales that would be available for the hunt or utilized different types of data to inform the probability of a WNP whale being taken (Moore and Weller 2013). Based on the preferred model, the probability of striking at least one WNP whale in a single year was estimated to range from 0.006 – 0.012 across different scenarios for the annual number of total gray whales that might be struck. This corresponds to an expectation of ≥ 1 WNP whale strike in one of every 83 to 167 years.

HABITAT CONCERNS

Near shore industrialization and shipping congestion throughout the migratory corridors of the WNP gray whale stock represent risks by increasing the likelihood of exposure to pollutants and ship strikes as well as a general degradation of the habitat. In addition, the summer feeding area off Sakhalin Island is a region rich with offshore oil and gas reserves. Two major offshore oil and gas projects now directly overlap or are in near proximity to this important feeding area, and more development is planned in other parts of the Okhotsk Sea that include the migratory routes of these whales. Operations of this nature have introduced new sources of underwater noise, including seismic surveys, increased shipping traffic, habitat modification, and risks associated with oil spills (Weller et al. 2002). During the past decade, a Western Gray Whale Advisory Panel, convened by the International Union for Conservation of Nature (IUCN), has been providing scientific advice on the matter of anthropogenic threats to gray whales in the WNP (see http://www.iucn.org/wgwap/). Ocean acidification could reduce the abundance of shell-forming organisms (Fabry et al. 2008, Hall-Spencer et al. 2008), many of which are important in the gray whales' diet (Nerini 1984).

STATUS OF STOCK

The WNP stock is listed as "Endangered" under the U.S. Endangered Species Act of 1973 (ESA) and is therefore also considered "strategic" and "depleted" under the MMPA. At the time the ENP stock was delisted, the WNP stock was thought to be geographically isolated from the ENP stock. Recent documentation of some whales moving between the WNP and ENP seems to indicate otherwise (Lang 2010; Mate et al. 2011; Weller et al. 2012; Urbán et al. 2013). Other research findings, however, provide continued support for identifying two separate stocks of North Pacific gray whales, including: (1) significant mitochondrial and nuclear genetic differences between whales that feed in the WNP and those that feed in the ENP (LeDuc et al. 2002; Lang et al. 2011), (2) recruitment into the WNP stock is almost exclusively internal (Cooke et al. 2013), and (3) the abundance of the WNP stock remains low while the abundance of the ENP stock grew steadily following the end of commercial whaling (Cooke et al. 2013). As long as the WNP stock remains listed as endangered under the ESA, it will continue to be considered as depleted under the MMPA.

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doi:10.7289/V5/TM-SWFSC-577

NOAA Technical Memorandum NMFS

JUNE 2017

U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENTS: 2016

James V. Carretta, Karin A. Forney, Erin M. Oleson, David W. Weller, Aimee R. Lang, Jason Baker, Marcia M. Muto, Brad Hanson, Anthony J. Orr, Harriet Huber, Mark S. Lowry, Jay Barlow, Jeffrey E. Moore, Deanna Lynch, Lilian Carswell, and Robert L. Brownell Jr.

NOAA-TM-NMFS-SWFSC-577

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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doi:10.7289/V5/TM-SWFSC-577

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JUNE 2017

U.S. PACIFIC MARINE MAMMAL STOCK ASSESSMENTS: 2016

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NOAA-TM-NMFS-SWFSC-577

U.S. DEPARTMENT OF COMMERCE
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PREFACE

Under the 1994 amendments to the Marine Mammal Protection Act (MMPA), the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) are required to publish Stock Assessment Reports for all stocks of marine mammals within U.S. waters, to review new information every year for strategic stocks and every three years for non-strategic stocks, and to update the stock assessment reports when significant new information becomes available.

Pacific region stock assessments include those studied by the Southwest Fisheries Science Center (SWFSC, La Jolla, CA), the Pacific Islands Fisheries Science Center (PIFSC, Honolulu, HI), the National Marine Mammal Laboratory (NMML, Seattle, WA), and the Northwest Fisheries Science Center (NWFSC, Seattle, WA). The 2016 Pacific marine mammal stock assessments include revised reports for 23 Pacific marine mammal stocks under NMFS jurisdiction, including eight "strategic" stocks: Hawaiian monk seal, Guadalupe fur seal, Southern Resident killer whale, California/Oregon/Washington humpback whale, California/Oregon/Washington fin whale, Eastern North Pacific sei whale, Main Hawaiian Islands Insular false killer whale, and Hawaii Pelagic false killer whale. New abundance estimates are available for 16 U.S. west coast stocks: Guadalupe fur seal, Washington Inland Waters harbor porpoise, California/Oregon/Washington stocks of Dall's porpoise, Pacific white-sided dolphin, Risso's dolphin, coastal and offshore stocks of common bottlenose dolphin, striped dolphin, short- and long-beaked common dolphin, northern right whale dolphin, short-finned pilot whale, pygmy sperm whale, fin whale, Eastern North Pacific sei whale and Southern Resident killer whales. New information on fishery-related serious injury and mortality has been updated for those stocks where possible. Updated estimates of stock abundance are also available for the Hawaiian monk seal.

New abundance estimates for several species along the U.S. west coast are considerably higher than previous estimates (Barlow 2016). This is attributed to two factors: 1) estimates of the trackline detection probability, *g(0)* are lower than in previous surveys, because new Beaufort sea state-specific estimates of *g(0)* have been calculated that better reflect differing probabilities of detection with increasing wind and swell (Barlow 2015); and 2) warm-temperate species such as short-beaked common dolphin, long-beaked common dolphin, and striped dolphin were encountered more frequently during a 2014 line-transect survey compared to previous years, due to anomalous warm-water conditions in the California Current (Barlow 2016, Cavole *et al*. 2016).

Human-caused mortality and injury documentation is often based on stranding data, where raw counts are negatively-biased because only a fraction of carcasses are detected (Williams *et al*. 2011), even for extremely coastal species (Wells *et al*. 2015). Carretta *et al*. (2016a) estimated that only 25% of California coastal bottlenose dolphin carcasses are recovered / documented, and given the extremely coastal habits of the population, Carretta *et al*. (2016a) argue that carcass recovery rates for this population represent a maximum rate, compared to more pelagic dolphin and porpoise species in the region. Therefore, for U.S. west coast stock assessment reports involving dolphins and porpoises, human-related deaths and injuries counted from mainland beach strandings are multiplied by a factor of 4 to account for the non-detection of most carcasses. Species / stocks for which the stranding correction factor has been applied include: California coastal bottlenose dolphin, Washington Inland waters harbor porpoise, Risso's dolphin, striped dolphin, and short-beaked and long-beaked common dolphin. This carcass recovery correction factor has not been applied to large whale serious injuries and mortalities, because the method of detection for most large whale entanglement and vessel strike cases are opportunistic offshore sightings, and it is currently unknown what fraction of injured or dead large whales are detected at sea or ashore.

New estimates of human-caused mortality and serious injury are included for U.S. west coast stocks that interact with the California swordfish drift gillnet fishery (Carretta *et al*. 2016b). Estimates are model-based and are based on inclusion of 25 years of bycatch data, in contrast to previous ratio estimates of bycatch that relied on within-year data only (Carretta *et al*. 2014). The main effects of implementing model-based bycatch estimation are that resulting estimates are less volatile inter-annually, have better precision, and are less prone to biases associated with rare bycatch events and low observer coverage (Carretta and Moore 2014). Model-based estimates also result in positive estimates of bycatch even in years when no bycatch of a particular species is recorded by fishery observers.

This is a working document and individual stock assessment reports will be updated as new information on marine mammal stocks and fisheries becomes available. Background information and guidelines for preparing stock assessment reports are reviewed in Wade and Angliss (1997). The authors solicit any new information or comments which would improve future stock assessment reports.

Draft versions of the 2016 stock assessment reports were reviewed by the Pacific Scientific Review Group at the February 2016 meeting.

These Stock Assessment Reports summarize information from a wide range of original data sources and an extensive bibliography of all sources is given in each report. We recommend users of this

document refer to and cite *original* literature sources cited within the stock assessment reports rather than citing this report or previous Stock Assessment Reports.

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PINNIPEDS

CETACEANS - U.S. WEST COAST

CETACEANS – HAWAII & WESTERN PACIFIC

APPENDICES

GRAY WHALE (*Eschrichtius robustus*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Once common throughout the Northern Hemisphere, the gray whale was extinct in the Atlantic by the early 1700s (Fraser 1970; Mead and Mitchell 1984), though one anomalous sighting occurred in the Mediterranean Sea in 2010 (Scheinin *et al.* 2011) and another off Namibia in 2013 (Elwen and Gridley 2013). Gray whales are now only commonly found in the North Pacific. Genetic comparisons indicate there are distinct "Eastern North Pacific" (ENP) and "Western North Pacific" (WNP) population stocks, with differentiation in both mtDNA haplotype and microsatellite allele frequencies (LeDuc et al. 2002; Lang et al. 2011a; Weller et al. 2013).

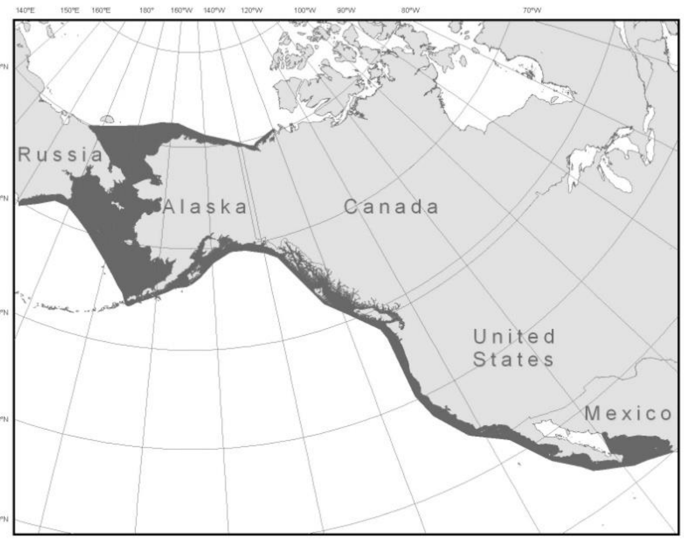

Figure 1. Approximate distribution of the Eastern North Pacific stock of gray whales (shaded area).

During summer and fall, most whales in the ENP population feed in the Chukchi, Beaufort and northwestern Bering Seas (Fig. 1). An exception to this is the relatively small number of whales (approximately 200) that summer and feed along the Pacific coast between Kodiak Island, Alaska and northern California (Darling 1984, Gosho *et al.* 2011, Calambokidis *et al.* 2012), referred to as the "Pacific Coast Feeding Group" (PCFG). Three primary wintering lagoons in Baja California, Mexico are utilized, and some females are known to make repeated returns to specific lagoons (Jones 1990). Genetic substructure on the wintering grounds is indicated by significant differences in mtDNA haplotype frequencies between females (mothers with calves) using two of the primary calving lagoons and females sampled in other areas (Goerlitz *et al*. 2003). Other research identified a small, but significant departure from panmixia between two of the lagoons using nuclear data, although no significant differences were identified using mtDNA (Alter *et al.* 2009).

Tagging, photo-identification and genetic studies show that some whales identified in the WNP off Russia have been observed in the ENP, including coastal waters of Canada, the U.S. and Mexico (Lang 2010; Mate et al. 2011; Weller et al. 2012; Urbán et al. 2013, Mate et al. 2015). In combination, these studies have recorded a total of 27 gray whales observed in both the WNP and ENP. Despite this overlap, significant mtDNA and nDNA differences are found between whales in the WNP and those summering in the ENP (Lang *et al*. 2011a).

In 2010, the IWC Standing Working Group on Aboriginal Whaling Management Procedure noted that different names had been used to refer to gray whales feeding along the Pacific coast, and agreed to designate animals that spend the summer and autumn feeding in coastal waters of the Pacific coast of North America from California to southeast Alaska as the "Pacific Coast Feeding Group" or PCFG (IWC 2012). This definition was further refined for purposes of abundance estimation, limiting the geographic range to the area from northern California to northern British Columbia (from 41°N to 52°N), limiting the temporal range to the period from June 1 to November 30, and counting only those whales seen in more than one year within this geographic and temporal range (IWC 2012). The IWC adopted this definition in 2011, but noted that "not all whales seen within the PCFG area at this time will be PCFG whales and some PCFG whales will be found outside of the PCFG area at various times during the year." (IWC 2012).

Photo-identification studies between northern California and northern British Columbia provide data on the abundance and population structure of PCFG whales (Calambokidis *et al*. 2012). Gray whales using the study area in summer and autumn include two components: **1)** whales that frequently return to the area, display a high degree of intra-seasonal " fidelity" and account for a majority of the sightings between 1 June and 30 November. Despite movement and interchange among sub-regions of the study area, some whales are more likely to return to the same sub-region where they were observed in previous years; **2)**"visitors" from the northbound migration that are sighted only in one year, tend to be seen for shorter time periods in that year, and are encountered in more limited areas. Photo-identification (Gosho *et al*. 2011; Calambokidis *et al*. 2012) and satellite tagging (Mate *et al*. 2010; Ford *et al.*

2012) studies have documented some PCFG whales off Kodiak Island, the Gulf of Alaska and Barrow, Alaska, well to the north of the pre-defined 41°N to 52°N boundaries used in some PCFG-related analyses (e.g. abundance estimation).

Frasier *et al.* (2011) found significant differences in mtDNA haplotype distributions between PCFG and ENP gray whale sequences, in addition to differences in long-term effective population size, and concluded that the PCFG qualifies as a separate management unit under the criteria of Moritz (1994) and Palsbøll *et al.* (2007). The authors noted that PCFG whales probably mate with the rest of the ENP population and that their findings were the result of maternally-directed site fidelity of whales to different feeding grounds.

Lang *et al.* (2011b) assessed stock structure of ENP whales from different feeding grounds using both mtDNA and eight microsatellite markers. Significant mtDNA differentiation was found when samples from individuals (n=71) sighted over two or more years within the seasonal range of the PCFG were compared to samples from whales feeding north of the Aleutians (n=103), and when PCFG samples were compared to samples collected off Chukotka, Russia (n=71). No significant differences were found when these same comparisons were made using microsatellite data. The authors concluded that (1) the significant differences in mtDNA haplotype frequencies between the PCFG and whales sampled in northern areas indicates that use of some feeding areas is being influenced by internal recruitment (e.g., matrilineal fidelity), and (2) the lack of significance in nuclear comparisons suggests that individuals from different feeding grounds may interbreed. The level of mtDNA differentiation identified, while statistically significant, was low and the mtDNA haplotype diversity found within the PCFG was similar to that found in the northern strata. Lang *et al*. (2011b) suggested this could indicate recent colonization of the PCFG but could also be consistent with external recruitment into the PCFG. An additional comparison of whales sampled off Vancouver Island, British Columbia (representing the PCFG) and whales sampled at the calving lagoon at San Ignacio also found no significant differences in microsatellite allele frequencies, providing further support for interbreeding between the PCFG and the rest of the ENP stock (D'Intino et al. 2012). Lang and Martien (2012) investigated potential immigration levels into the PCFG using simulations and produced results consistent with the empirical (mtDNA) analyses of Lang et al. (2011b). Simulations indicated that immigration of >1 and <10 animals per year into the PCFG was plausible, and that annual immigration of 4 animals/year produced results most consistent with the empirical study.

While the PCFG is recognized as a distinct feeding aggregation (Calambokidis et al. 2012; Mate et al. 2010; Frasier et al. 2011; Lang et al. 2011b; IWC 2012), the status of the PCFG as a population stock remains unresolved (Weller et al. 2013). A NMFS gray whale stock identification workshop held in 2012 included a review of available photo-identification, genetic, and satellite tag data. The report of the workshop states "there remains a substantial level of uncertainty in the strength of the lines of evidence supporting demographic independence of the PCFG." (Weller et al. 2013). The NMFS task force, charged with evaluating stock status of the PCFG, noted that "both the photo-identification and genetics data indicate that the levels of internal versus external recruitment are comparable, but these are not quantified well enough to determine if the population dynamics of the PCFG are more a consequence of births and deaths within the group (internal dynamics) rather than related to immigration and/or emigration (external dynamics)." Further, given the lack of significant differences found in nuclear DNA markers between PCFG whales and other ENP whales, the task force found no evidence to suggest that PCFG whales breed exclusively or primarily with each other, but interbreed with ENP whales, including potentially other PCFG whales. Additional research is needed to better identify recruitment levels into the PCFG and further assess the stock status of PCFG whales (Weller et al. 2013). In contrast, the task force noted that WNP gray whales should be recognized as a population stock under the MMPA, and NMFS prepared a separate report for WNP gray whales in 2014. Because the PCFG appears to be a distinct feeding aggregation and may warrant consideration as a distinct stock in the future, separate PBRs are calculated for the PCFG to assess whether levels of human-caused mortality are likely to cause local depletion.

POPULATION SIZE

Systematic counts of gray whales migrating south along the central California coast have been conducted by shore-based observers at Granite Canyon most years since 1967 (Fig. 2). The most recent estimate of abundance for the ENP population is from the 2010/2011 southbound survey and is 20,990 (CV=0.05) whales (Durban *et al*. 2013) (Fig. 2).

Photographic mark-recapture abundance estimates for PCFG gray whales between 1998 and 2012, including estimates for a number of smaller geographic areas within the IWC-defined PCFG region (41°N to 52°N), are reported in Calambokidis *et al*. (2014). The 2012 abundance estimate for the defined range of the PCFG between 41°N to 52°N is 209 (SE=15.4; CV= 0.07).

Eastern North Pacific gray whales experienced an unusual mortality event (UME) in 1999 and 2000, when large numbers of emaciated animals stranded along the west coast of North America (Moore *et al*., 2001; Gulland *et al*., 2005). Over 60% of the dead whales were adults, compared with previous years when calf strandings were more common. Several factors following this UME suggest that the high mortality rate observed was a short-term, acute event and not a chronic situation or trend: 1) in 2001 and 2002, strandings decreased to levels below UME levels (Gulland *et al*., 2005); 2) average calf production returned to levels seen before 1999; and 3) in 2001, living whales no longer appeared emaciated. Oceanographic factors that limited food availability for gray whales were identified as likely causes of the UME (LeBouef et al. 2000; Moore et al. 2001; Minobe 2002; Gulland et al. 2005), with resulting declines in survival rates of adults during this period (Punt and Wade 2012). The population has recovered to levels seen prior to the UME of 1999-2000 (Fig. 2).

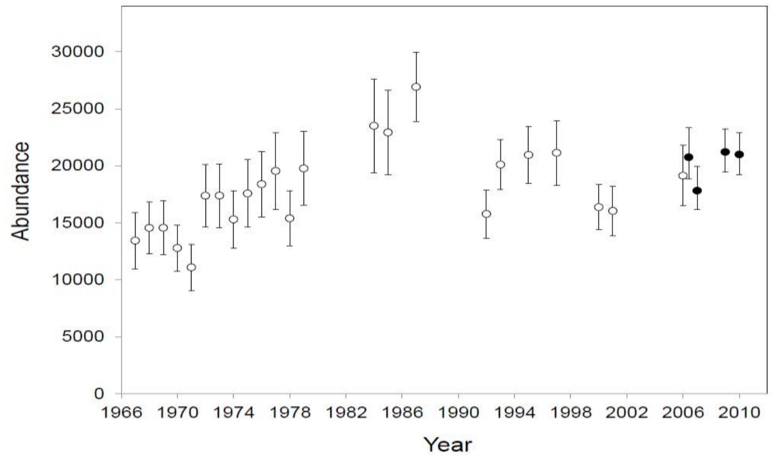

Figure 2. Estimated abundance of Eastern North Pacific gray whales from NMFS counts of migrating whales past Granite Canyon, California. Open circles represent abundance estimates and 95% confidence intervals reported by Laake et al. (2012). Closed circles represent estimates and 95% posterior highest density intervals reported by Durban et al. (2013) for the 2006/7, 2007/8, 2009/10, and 2010/11 migration seasons.

Gray whale calves have been counted from Piedras Blancas, a shore site in central California, in 1980-81 (Poole 1984a) and each year from 1994 to 2012 (Perryman *et al*. 2002; Perryman and Weller 2012). In 1980 and 1981, calves comprised 4.7% to 5.2% of the population (Poole 1984b). Calf production indices, as calculated by dividing northbound calf estimates by estimates of population abundance (Laake *et al*. 2012), ranged between 1.3 - 8.8% (mean=4.2%) during 1994-2012. Annual indices of calf production include impacts of early postnatal mortality but may overestimate recruitment because they exclude possibly significant levels of killer whale predation on gray whale calves north of the survey site (Barrett-Lennard et al. 2011). The relatively low reproductive output reported is consistent with little or no population growth over the time period (Laake *et al*. 2012; Punt and Wade 2012).

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for the ENP stock is calculated from Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1 + [CV(N)]^2)]^{½})$. Using the 2010/11 abundance estimate of 20,990 and its associated CV of 0.05 (Durban et al. 2013), N_{MIN} for this stock is 20,125.

The minimum population estimate for PCFG gray whales is calculated as the lower 20th percentile of the log-normal distribution of the 2012 mark-recapture estimate of 209 (CV=0.07), or 197 animals.

Current Population Trend

The population size of the ENP gray whale stock has increased over several decades despite an UME in 1999 and 2000 and has been relatively stable since the mid-1990s (see Fig. 2).

Abundance estimates of PCFG gray whales reported by Calambokidis et al. (2014) show a high rate of increase in the late 1990s and early 2000s, but have been relatively stable since 2003.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Using abundance data through 2006/07, an analysis of the ENP gray whale population led to an estimate of R_{max} of 0.062, with a 90% probability the value was between 0.032 and 0.088 (Punt and Wade 2012). This value of R_{max} is also applied to PCFG gray whales, as it is currently the best estimate of R_{max} available for gray whales in the ENP.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the ENP stock of gray whales is calculated as the minimum population size (20,125), times one-half of the maximum theoretical net population growth rate (½ x 6.2% = 3.1%), times a recovery factor of 1.0 for a stock above MNPL (Punt and Wade 2012), or 624 animals per year.

The potential biological removal (PBR) level for PCFG gray whales is calculated as the minimum population size (197 animals), times one half the maximum theoretical net population growth rate (½ x 6.2% = 3.1%), times a recovery factor of 0.5 (for a population of unknown status), resulting in a PBR of 3.1 animals per year. Use of the recovery factor of 0.5 for PCFG gray whales, rather than 1.0 used for ENP gray whales, is based on uncertainty regarding stock structure (Weller et al. 2013) and guidelines for preparing marine mammal stock assessments which state that "Recovery factors of 1.0 for stocks of unknown status should be reserved for cases where there is assurance that N_{min}, R_{max}, and the kill are unbiased and where the stock structure is unequivocal" (NMFS 2005). Given uncertainties in the levels of external versus internal recruitment of PCFG whales described above, the equivocal nature of the stock structure, and the small estimated population size of the PCFG, NMFS will continue to use the default recovery factor of 0.5 for PCFG gray whales.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Serious Injury Guidelines

NMFS uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases todistinguishserious from non-serious injury (Angliss and DeMaster 1998, Andersen *et al*. 2008, NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*".

Fisheries Information

No gray whales were observed entangled in California gillnet fisheries between 2008 and 2012 (Carretta and Enriquez 2009, 2010, 2012a, 2012b, Carretta *et al*., 2014a.), but previous mortality in the swordfish drift gillnet fishery has been observed (Carretta et al. 2004) and there have been recent sightings of free-swimming gray whales entangled in gillnets (Table 1). Alaska gillnet fisheries largely lack observer programs, including those in Bristol Bay known to interact with gray whales. Most data on human-caused mortality and serious injury of gray whales are from strandings, including at-sea reports of entangled animals alive or dead (Carretta et al. 2013, 2014b). Strandings represent only a fraction of actual gray whale deaths (natural or human-caused), as reported by Punt and Wade (2012), who estimated that only 3.9% to 13.0% of gray whales that die in a given year end up stranding and being reported.

A summary of human-caused mortality and serious injury resulting from unknown fishery and marine debris sources (mainly pot/trap or net fisheries) is given in Table 1 for the most recent 5-year period of 2008 to 2012. Total observed human-caused fishery mortality and serious injury for ENP gray whales is 22.25 animals (8 serious injuries, 8.25 prorated serious injuries, and 6 deaths), or 4.45 whales per year (Table 1). Total observed human-caused fishery mortality and serious injury for gray whales observed in the PCFG range and season for the period 2008 to 2012 is 0.75 animals (0.75 prorated serious injuries), or 0.15 whales per year (Table 1). Three gray whales from Table 1 (one death and two serious injuries) were detected in California waters during the known PCFG season, but were south of the area recognized by the IWC as the PCFG management area. It is possible that some of these whales could be PCFG whales, but no photographic identifications were available to establish their identity. They are included in ENP gray whale serious injury and death totals.

Table 1. Human-caused deaths and serious injuries (SI) of gray whales from fishery-related and marine debris sources for the period 2008 to 2012 as recorded by NMFS stranding networks and observer programs.

Date of observation	Location	PCFG range N 41- N 52 AND season?	Description	Determination (SI Prorate value)
13-Oct-2012	Fort Bragg, CA	No	Entangled animal report; animal reported with rope around the peduncle which wasn't seen in photographs but photos did show green gillnet with cuts to the head; animal disappeared and final status is unknown.	SI
31-Aug-2012	Los Angeles, CA	No	Animal first detected near San Diego. Subadult gray whale reported entangled with small gauge, dark-colored line deeply embedded around its tail stock. Little gear trails. Entanglement was once more involved as indicated by scars on the animal's body. Animal in very poor condition - emaciated, scarred and a heavy load of cyamid	Dead

			amphipods. Black line around peduncle, 20 ft trailing; observed off san San Diego on 8/31, completely disentangled off L.A. 9/6, stranded dead 9/14/12.	
22-Aug-2012	Prince William Sound, AK	No	Whale sighted by tour boat. Few details, other than part of a fishing net was observed being trailed from a gray whale's fin. Photos apparently available, but have not been located. Prince william William Sound. Extent and severity of entanglement unknown.	SI (0.75)
16-Jun-2012	Prince William Sound, AK	No	30' gray whale in prince william Prince William Sound entangled in gear. Thrashing at surface and moving at 4-5 knots. No wounds or chafing was observed. Gillnet, corkline (at least 12 floats), and leadline observed over animal's rostrum, body, and tailstock. Both pectoral flippers appeared pinned to body. Animal later appeared tired and was swimming at 2 knots. It was not relocated. Assigned serious injury because gear appears to be constricting movement of whale's flippers.	SI
13-May-2012	Monterey, CA	No	Animal entangled through mouth in at least two sets of suspected pot gear that that hang below. Animal anchored with a short scope in 28 feet of water to suspected pots. Bundle of gear, including 4 buoys lie under animal. Animal having some difficulty getting to surface. Animal eventually disentangled, but results of entanglement may still be life-threatening.	SI
8-May-2012	Eureka, CA	No	Entangled animal report; deep cuts from rope around peduncle and lacerations at fluke notch and lateral edge of fluke; successfully disentangled but long-term survival noted as questionable. Gear was collected and identified as Dungeness crab pot gear. Animal entirely freed of gear. Animal in fair condition and slightly emaciated. Deep cuts (~ 2 inches) from the rope around the peduncle remained. Gear was recovered. Results of entanglement may still be life threatening.	SI
5-May-2012	Monterey, CA	No	Whale watch vessel noticed from images taken of a 20 - 25 foot gray whale they had been observing earlier in the day, that animal was actually entangled. A small gauge line, likely from right side of mouth goes over the animal's back, and over blowholes, to left side of mouth. No buoys or trailing line were observed. Animal in fair condition. Animal sighted next day by whale watch vessel. Confirmed mouth entanglement, appears to be strapping material.	SI (0.75)
28-Apr-2012	Fort Bragg, CA	No	Small gray whale off fort bragg Fort Bragg, CA, in company of two other animals, trailing two buoys.	SI (0.75)
21-Apr-2012	San Simeon, CA	No	Rope like marks on caudal peduncle. Rope impression on pectoral fin. Photos taken.	Dead
17-Apr-2012	Laguna Beach, CA	No	40-foot gray whale reported entangled with approximately 150 feet of line trailing. Four spongex bullet buoys lie along the left side of the animal. Entanglement involves the mouth, a wrap over the head, and the left pectoral flipper. Entanglement appears recent. Partially disentangled on 5/3/12 by fishermen.	SI (0.75)
24-Mar-2012	San Diego, CA	No	Entangled animal report; gillnet gear around peduncle; response effort resulted in successful disentanglement with >100 ft of pink gillnet removed from animal, but animal subsequently observed dead on 03/27 (floating, skin sample taken, no necropsy). Net removed on 03/24 found to contain one dead ca sea lion and three dead sharks.	Dead
28-Jan-2012	San Diego, CA	No	Entangled animal report; towing two orange buoys and at least 150 feet of line; unknown fishery, reported as possible gillnet; no response effort.	SI (0.75)
17-Jan-2012	Unimak Pass, AK	No	A 40' whale was caught in cod pot gear near Unimak Pass. Lines were cut by boat crew and buoys were recovered, however, the pot and some line remained in the water. Any line possibly remaining on animal thought to be minimal. Gray whale species determination made following extensive questioning by local biologist. Determination: prorated serious injury because gear possibly remains on animal.	SI (0.75)
25-Aug-2011	San Mateo, CA	No	One white "crab pot" buoy next to body by left pectoral fin; float stayed next to body and did not change position; animal remained in same position - possibly anchored; only observed for ~2 min; not resighted, no rescue, outcome unknown.	SI
12-Sep-2010	Central Bering Sea	No	Bering Sea / Aleutian Islands flatfish trawl fishery: 12 m animal caught in gear. Photos taken.	Dead
11-May-2010	Orange County CA	No	Free-swimming animal entangled in gillnet; animal first observed inside Dana Point Harbor on 5/11/10; animal successfully	Dead

			disentangled on 5/12/10 & swam out of harbor; animal observed alive in surf zone for several hours on 5/14/10 off Doheny State Beach before washing up dead on beach	
7-May-2010	Cape Foulweather OR	No	Entangled in 3 crab pots, whale not relocated.	SI (0.75)
16-Apr-2010	Seaside OR	No	27-ft long gray whale stranded dead, entangled in crab pot gear	Dead
8-Apr-2010	San Francisco CA	No	Rope wrapped around caudal peduncle; identified as gray whale from photo. Free-swimming, diving. No rescue effort, no resightings, final status unknown	SI
5-Mar-2010	San Diego	No	Free-swimming entangled whale reported by member of the public; no rescue effort initiated; no resightings reported; final status unknown.	SI (0.75)
21-Jul-2009	Trinidad Head CA	Yes	Free-swimming animal with green gillnet, rope & small black floats wrapped around caudal peduncle; report received via HSU researcher on scene during research cruise; animal resighted on 3 Aug; no rescue effort initiated. Photos show rope cutting into caudal peduncle. This whale was re-sighted in 2010 and 2011, still trailing gear. Whale was resighted in 2013 and had shed gear, and was apparently in good health (Jeff Jacobsen, pers. comm.).	NSI
24-Jun-2009	Clallam County, WA	Yes	Whale found entangled in tribal set gillnet in morning. Net had been set 8 pm previous day. Whale able to breath, but not swim freely and was stationary in net. Right pectoral flipper and head were well-wrapped in net webbing. In response to disentanglement attempts, whale reacted violently and swam away. The net was retrieved and found to be torn in two. No confirmation on whether whale was completely free of netting.	SI (0.75)
9-Apr-2009	Sitka, AK	No	Thick black line wrapped twice around whale's body posterior to the eyes was cut and pulled away by private citizen. Animal swam away and dove.	SI (0.75)
25-Mar-2009	Seal Beach CA	No	Free-swimming animal with pink gillnet wrapped around head, trailing 4 feet of visible netting; report received via naturalist on local whale watch vessel; no rescue effort initiated; final status unknown	SI (0.75)
31-Jan-2009	San Diego CA	No	Free-swimming animal towing unidentified pot/trap gear; report received via USCG on scene; USCG reported gear as 4 lobster pots; final status unknown	SI (0.75)
16-Apr-2008	Eel River CA	No	Observed 12 miles west of Eel River by Humboldt State University personnel. It was unknown sex, with an estimated length of 20 ft and in emaciated condition. The animal was described as towing 40-50 feet of line & 3 crab pot buoys from the caudal peduncle and moving very slowly. Vessel retrieved the buoys, pulled them and ~20 ft of line onto the deck and cut it loose from the whale. The whale swam away slowly with 20-30 feet of line still entangling the peduncle, outcome unknown. Identification numbers on buoy traced to crab pot fishery gear that was last fished in Bering Sea in December 2007.	SI

Subsistence/Native Harvest Information

Subsistence hunters in Russia and the United States have traditionally harvested whales from the ENP stock in the Bering Sea, although only the Russian hunt has persisted in recent years (Huelsbeck 1988; Reeves 2002). In 2005, the Makah Indian Tribe requested authorization from NOAA/NMFS, under the MMPA and the Whaling Convention Act, to resume limited hunting of gray whales for ceremonial and subsistence purposes in the coastal portion of their usual and accustomed (U&A) fishing grounds off Washington State (NMFS 2008). The spatial overlap of the Makah U&A and the summer distribution of PCFG whales has management implications. The proposal by the Makah Tribe includes time/area restrictions designed to reduce the probability of killing a PCFG whale and to focus the hunt on whales migrating to/from feeding areas to the north. The Makah proposal also includes catch limits for PCFG whales that result in the hunt being terminated if these limits are met. Also, observations of gray whales moving between the WNP and ENP highlight the need to estimate the probability of a gray whale observed in the WNP being taken during a hunt by the Makah Tribe (Moore and Weller 2013). NMFS has published a notice of intent to prepare an environmental impact statement (EIS) on the proposed hunt (NMFS 2012) and the IWC has evaluated the potential impacts of the proposed hunt and other sources of human-caused mortality on PCFG whales and concluded, with certain qualifications, that the proposed hunt meets the Commission's conservation objectives (IWC 2013). The Scientific Committee has not scheduled an implementation review of the impacts of the Makah hunt on whales using summering feeding areas in the WNP, but is continuing to investigate stock structure of north Pacific gray whales and may schedule such a review in the future (IWC 2013). In 2012, the IWC approved a 6-year quota (2013-2018) of 744 gray whales, with an annual cap of 140, for Russian and U.S. (Makah Indian Tribe) aboriginals based on the joint request and needs statements submitted by the U.S. and Russian federation. The U.S. and Russia have agreed that the quota will be shared with an average annual harvest of 120 whales by the Russian Chukotka people and 4 whales by the Makah Indian Tribe. Total takes by the Russian hunt during the past five years were: 130 in 2008,116 in 2009, 118 in 2010, 128 in 2011, and 143 in 2012 (source: http://iwc.int/table_aboriginal). Based on this information, the annual subsistence take averaged 127 whales during the 5-year period from 2008 to 2012.

Other Mortality

Ship strikes are a source of mortality for gray whales (Table 2). For the most recent five-year period, 2008-2012, the total serious injury and mortality of ENP gray whales attributed to ship strikes is 9.8 animals (including 7 deaths, 2 serious injuries, and 0.8 prorated serious injuries, or 2.0 whales per year (Table 2, Carretta et al. 2013, Carretta et al. 2014b.). The total ship strike serious injury and mortality of gray whales observed in the PCFG range and season during this same period is 0.52 animals, or 0.1 whales per year (Table 2). One gray whale ship strike in Table 2 was detected in California waters during the known PCFG season, but was south of the area recognized by the IWC as the PCFG management area. It is possible that this animal could be a PCFG whale, but no photographic identification was available to establish its identity. It is included in ENP gray whale serious injury and death totals. Additional mortality from ship strikes probably goes unreported because the whales either do not strand or do not have obvious signs of trauma.

In February 2010, a gray whale stranded dead near Humboldt, CA with parts of two harpoons embedded in the body. Since this whale was likely harpooned during the aboriginal hunt in Russian waters, it would have been counted as “struck and lost” in the harvest data.

HABITAT CONCERNS

Near shore industrialization and shipping congestion throughout the migratory corridors of the ENP gray whale stock represent risks by increasing the likelihood of exposure to pollutants and ship strikes, as well as a general degradation of the habitat.

Evidence indicates that the Arctic climate is changing significantly, resulting in a reductions in sea ice cover (Johannessen et al. 2004, Comiso et al. 2008). These changes are likely to affect gray whales. For example, the summer range of gray whales has greatly expanded in the past decade (Rugh et al. 2001). Bluhm and Gradinger (2008) examined the availability of pelagic and benthic prey in the Arctic and concluded that pelagic prey is likely to increase while benthic prey is likely to decrease in response to climate change. They noted that marine mammal species that exhibit trophic plasticity (such as gray whales which feed on both benthic and pelagic prey) will adapt better than trophic specialists.

Global climate change is also likely to increase human activity in the Arctic as sea ice decreases, including oil and gas exploration and shipping (Hovelsrud et al. 2008). Such activity will increase the chance of oil spills and ship strikes in this region. Gray whales have demonstrated avoidance behavior to anthropogenic sounds associated with oil and gas exploration (Malme et al. 1983, 1984) and low-frequency active sonar during acoustic playback experiments (Buck and Tyack 2000, Tyack 2009). Ocean acidification could reduce the abundance of shell-forming organisms (Fabry et al. 2008, Hall-Spencer et al. 2008), many of which are important in the gray whales’ diet (Nerini 1984).

Table 2. Summary of gray whale serious injuries (SI) and deaths attributed to vessel strikes for the five-year period 2008-2012. No vessel strikes were reported in 2012.

Date of observation	Location	PCFG range N 41 - N 52 AND season?	Description	Determination (SI prorate value)
6-Jun-2011	San Mateo CA	No	Massive hemorrhage into the thorax, blood clots around lungs. Lesions indicate massive trauma. Due to carcass position, the skeleton could not be completely examined (lying on back, top of skull in sand).	Dead
8-Apr-2011	San Francisco CA	No	Crushed mandible.	Dead
12-Feb-2011	Los Angeles CA	No	Private recreational vessel collided with free-swimming animal; animal breached just prior to contact, bouncing off side of vessel; dove immediately following contact & was not resighted; no blood observed in water; final status unknown; skin sample collected from vessel and genetically identified	SI (0.14)

			as a female gray whale. Vessel size assumed less than 65 ft and speed unknown.	
22-Jan-2011	San Diego CA	No	Pleasure sailboat collided with free-swimming animal; animal dove immediately following contact & was not resighted; no blood observed in water; final status unknown. Vessel size assumed less than 65 ft. And speed unknown.	SI (0.14)
12-Mar-2010	Santa Barbara CA	No	21 meter sailboat underway at 13 kts collided with free-swimming animal; whale breached shortly after collision; no blood observed in water; minor damage to lower portion of boat's keel; final status unknown; DNA analysis of skin sample confirmed species.	SI
16-Feb-2010	San Diego CA	No	Free-swimming animal with propeller-like wounds to dorsum.	SI (0.52)
9-Sep-2009	Quileute River WA	Yes	USCG vessel reported to be traveling at 10 knots when they hit the gray whale at noon on 9/9/2009. The animal was hit with the prop and was reported alive after being hit, blood observed in water.	SI (0.52)
1-May-2009	Los Angeles CA	No	Catalina island transport vessel collided with free-swimming calf accompanied by adult animal; calf was submerged at time of collision; pieces of flesh & blood observed in water; calf never surfaced; presumed mortality.	SI
27-Apr-2009	Whidbey Is. WA	No	Large amount of blood in body cavity, bruising in some areas of blubber layer and in some internal organs. Findings suggestive of blunt force trauma likely caused by collision with a large ship.	Dead
5-Apr-2009	Sunset Beach CA	No	Dead stranding; 3 deep propeller-like cuts on right side, just anterior of genital opening; carcass towed out to sea	Dead
4-Apr-2009	Ilwaco WA	No	Necropsied, broken bones in skull; extensive hemorrhage head and thorax; sub-adult male	Dead
1-Mar-2008	Mexico	No	Carcass brought into port on bow of cruise ship; collision occurred betweeen ports of San Diego and Cabo San Lucas between 5:00 p.m. On 2/28 & 7:20 a.m. On 3/1	Dead
7-Feb-2008	Orange County CA	No	Carcass; propeller-like wounds to left dorsum from mid-body to caudal peduncle; deep external bruising on right side of head; field necropsy revealed multiple cranial fractures	Dead

STATUS OF STOCK

In 1994, the ENP stock of gray whales was removed from the List of Endangered and Threatened Wildlife (the List), as it was no longer considered endangered or threatened under the Endangered Species Act (NMFS 1994). Punt and Wade (2012) estimated the ENP population was at 85% of carrying capacity (K) and at 129% of the maximum net productivity level (MNPL), with a probability of 0.884 that the population is above MNPL and therefore within the range of its optimum sustainable population (OSP).

Even though the stock is within OSP, abundance will fluctuate as the population adjusts to natural and human-caused factors affecting carrying capacity (Punt and Wade 2012). It is expected that a population close to or at carrying capacity will be more susceptible to environmental fluctuations (Moore et al. 2001). The correlation between gray whale calf production and environmental conditions in the Bering Sea may reflect this (Perryman et al. 2002; Perryman and Weller 2012). Overall, the population nearly doubled in size over the first 20 years of monitoring and has fluctuated for the last 30 years around its average carrying capacity. This is consistent with a population approaching K.

Based on 2008-2012 data, the estimated annual level of human-caused mortality and serious injury for ENP gray whales includes Russian harvest (127), mortality and serious injury from commercial fisheries (4.45), and ship strikes (2.0), totals 133 whales per year, which does not exceed the PBR (624). The IWC completed an implementation review for ENP gray whales (including the PCFG) in 2012 (IWC 2013) and concluded that harvest levels (including the proposed Makah hunt) and other human caused mortality are sustainable, given the current population abundance (Laake et al. 2012, Punt and Wade 2012). Therefore, the ENP stock of gray whales is not classified as a strategic stock.

PCFG gray whales do not currently have a formal status under the MMPA, though the population size appears to have been stable since 2003, based on photo-ID studies (Calambokidis et al. 2014, IWC 2012). Total annual human-caused mortality of PCFG gray whales during the period 2008 to 2012 includes deaths due to commercial fisheries (0.15/yr), and ship strikes (0.1/yr), or 0.25 whales annually. This does not exceed the PBR level of 3.1 whales for this population. Levels of human-caused mortality and serious injury resulting from commercial fisheries and ship strikes for both ENP and PCFG whales represent minimum estimates as recorded by stranding networks or at-sea sightings.

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GRAY WHALE (*Eschrichtius robustus*): Western North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Gray whales occur along the eastern and western margins of the North Pacific. In the western North Pacific (WNP), gray whales feed during summer and fall in the Okhotsk Sea off northeast Sakhalin Island, Russia, and off southeastern Kamchatka in the Bering Sea (Weller et al. 1999, 2002; Vertyankin et al. 2004; Tyurneva et al. 2010; Burdin et al. 2013; Figure 1). Some gray whales observed feeding off Sakhalin and Kamchatka migrate during the winter to the west coast of North America in the eastern North Pacific (Mate et al. 2011; Weller et al. 2012; Urbán *et al*. 2013), while others, including at least one whale first identified as a calf off Sakhalin, migrate to areas off Asia in the WNP (Weller et al. 2008; Weller et al. 2013a). Despite the observed movements between the WNP and eastern North Pacific (ENP), genetic comparisons show significant mitochondrial and nuclear genetic differences between whales sampled in the ENP and those sampled on the feeding ground off Sakhalin Island in the WNP (LeDuc et al. 2002; Lang et al. 2011). While a few previously unidentified non-calves are identified annually, a recent population assessment using photo-identification data from 1994 to 2011 fitted to an individually-based model found that whales feeding off Sakhalin Island have been demographically self-contained, at least in recent years, as new recruitment to the population is almost exclusively a result of calves born to mothers from within the group (Cooke et al. 2013).

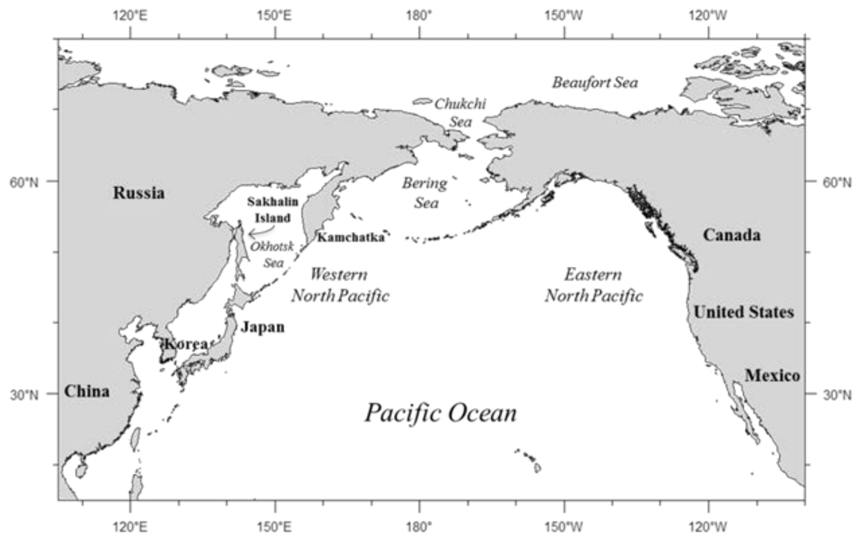

Figure 1. Range map of the Western North Pacific Stock of gray whales, including summering areas off Russia and wintering areas in the western and eastern Pacific.

Historical evidence indicates that the coastal waters of eastern Russia, the Korean Peninsula and Japan were once part of the migratory route in the WNP and that areas in the South China Sea may have been used as wintering grounds (Weller et al. 2002; Weller et al. 2013a). However, contemporary records of gray whales off Asia are rare, with only 13 from Japanese waters between 1990 and 2007 (Nambu *et al*. 2010) and 24 from Chinese waters since 1933 (Wang 1984; Zhu 2002). The last known record of a gray whale off Korea was in 1977 (Park 1995; Kim et al. 2013). While recent observations of gray whales off the coast of Asia are infrequent, they nevertheless continue to occur, including: (1) March/April 2014 - one or possibly two gray whales were sighted and photographed off the Shinano River in Teradomari (Niigata Prefecture) on the Sea of Japan coast of Honshu, Japan (Kato et al. 2014), (2) March 2012 - a gray whale was sighted and photographed in Mikawa Bay (Aichi Prefecture), on the Pacific coast of Honshu, Japan (Kato *et al*. 2012), and (3) November 2011 - a 13 m female gray whale was taken in fishing gear offshore of Baiqingxiang, China, in the Taiwan Strait (Zhu 2012).

Information from tagging, photo-identification and genetic studies show that some whales identified in the WNP off Russia have been observed in the ENP, including coastal waters of Canada, the U.S. and Mexico (Lang 2010; Mate et al. 2011; Weller et al. 2012; Urbán et al. 2013, Mate et al. 2015). In combination, these studies have recorded a total of 27 gray whales observed in both the WNP and ENP. Some whales that feed off Sakhalin Island in summer migrate east across the Pacific to the west coast of North America in winter, while others migrate south to waters off Japan and China. Taken together, these observations indicate that not all gray whales in the WNP share a common wintering ground (Weller et al. 2013a).

In 2012, the National Marine Fisheries Service convened a scientific task force to appraise the currently recognized and emerging stock structure of gray whales in the North Pacific (Weller et al. 2013b). The charge of the task force was to evaluate gray whale stock structure as defined under the Marine Mammal Protection Act (MMPA) and implemented through the National Marine Fisheries Service's Guidelines for Assessing Marine Mammal Stocks (GAMMS; NMFS 2005). Significant differences in both mitochondrial and nuclear DNA between whales sampled off Sakhalin Island (WNP) and whales sampled in the ENP provided convincing evidence that resulted in the task force advising that WNP gray whales should be recognized as a population stock under the MMPA and GAMMS guidelines. Given the interchange of some whales between the WNP and ENP, including seasonal occurrence of WNP whales in U.S. waters, the task force agreed that a stand-alone WNP gray whale population stock assessment report was warranted.

POPULATION SIZE

Photo-identification data collected between 1994 and 2011 on the gray whale summer feeding ground off Sakhalin Island in the WNP were used to calculate an abundance estimate of 140 (SE = ± 6, CV=0.043) whales for the age 1-plus (non-calf) population size in 2012 (Cooke et al. 2013). Some whales (approximately 70 individuals) sighted during the summer off southeastern Kamchatka have not been sighted off Sakhalin Island, but it is as yet unclear whether those whales are part of the WNP stock (IWC 2014).

Minimum Population Estimate

The minimum population estimate (N_{min}) for the WNP stock is calculated from Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{min} = N/\exp(0.842\times[\ln(1 +[CV(N)]^2)]½)$ and the abundance estimate of 140 (CV=0.043) whales from Cooke et al. (2013), resulting in a minimum population estimate of 135 gray whales on the summer feeding ground off Sakhalin Island in the WNP.

Current Population Trend

The WNP gray whale stock has increased over the last 10 years (2002-2012). The estimated realized average annual rate of population increase during this period is 3.3% per annum (± 0.5%) (Cooke et al. 2013).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

An analysis of the ENP gray whale population led to an estimate of R_{max} of 0.062, with a 90% probability the value was between 0.032 and 0.088 (Punt and Wade 2012). This value of R_{max} is also applied to WNP gray whales, as it is currently the best estimate of R_{max} available for any gray whale population.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (135), times one-half the estimated maximum annual growth rate for a gray whale population (½ of 6.2% for the Eastern North Pacific Stock, Punt and Wade 2012), times a recovery factor of 0.1 (for an endangered stock with $N_{min} < 1,500$, Taylor et al. 2003), and also multiplied by estimates for the proportion of the stock that uses U.S. EEZ waters (0.575) and the proportion of the year that those animals are in the U.S. EEZ (3 months, or 0.25 years) (Moore and Weller 2013), resulting in a PBR of 0.06 WNP gray whales per year, or approximately 1 whale every 17 years (if abundance and other parameters in the PBR equation remained constant over that time period).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Serious Injury Guidelines

NMFS uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to distinguis serious from non-serious injury (Angliss and DeMaster 1998, Andersen et al. 2008, NOAA 2012). NMFS defines serious injury as an "injury that is more likely than not to result in mortality".

Fisheries Information

The decline of gray whales in the WNP is attributable to commercial hunting off Korea and Japan between the 1890s and 1960s. The pre-exploitation abundance of WNP gray whales is unknown, but has been estimated to be between 1,500 and 10,000 individuals (Yablokov and Bogoslovskaya 1984). By 1910, after some commercial exploitation had already occurred, it is estimated that only 1,000 to 1,500 gray whales remained in the WNP population (Berzin and Vladimirov 1981). The basis for how these two estimates were derived, however, is not apparent (Weller et al. 2002). By the 1930s, gray whales in the WNP were considered by many to be extinct (Mizue 1951; Bowen 1974).

Today, a significant threat to gray whales in the WNP is incidental catches in coastal net fisheries (Weller et al. 2002; Kato et al. 2012; Weller et al. 2008; Weller et al. 2013a). Between 2005 and 2007, four female gray whales (including one mother-calf pair and one yearling) died in fishing nets on the Pacific coast of Japan. In addition, one adult female gray whale died as a result of a fisheries interaction in November 2011 off Pingtan County, China (Zhu 2012). An analysis of anthropogenic scarring of gray whales photographed off Sakhalin Island found that at least 18.7% (n=28) of 150 individuals identified between 1994 and 2005 had evidence of previous entanglements in fishing gear (Bradford et al. 2009), further highlighting the overall risks coastal fisheries pose to WNP gray whales.

In summer 2013, salmon net fishing was observed for the first time on the gray whale feeding ground off Sakhalin Island. Observations of whales within 100 m of salmon fishing nets have been made and a male gray whale was observed dragging fishing gear (rope), with a related injury on the caudal peduncle at the dorsal insertion point with the flukes (Weller et al. 2014).

Given that some WNP gray whales occur in U.S. waters, there is some probability of WNP gray whales being killed or injured by ship strikes or entangled in fishing gear within U.S. waters.

Subsistence/Native Harvest Information

In 2005, the Makah Indian Tribe requested authorization from NOAA/NMFS, under the Marine Mammal Protection Act of 1972 (MMPA) and the Whaling Convention Act, to resume limited hunting of gray whales for ceremonial and subsistence purposes in the coastal portion of their usual and accustomed (U&A) fishing grounds off Washington State (NOAA 2008). Observations of gray whales moving between the WNP and ENP highlight the need to estimate the probability of a gray whale observed in the WNP being taken during a hunt by the Makah Tribe (Moore and Weller 2013). Given conservation concerns for the WNP population, the Scientific Committee of the International Whaling Commission (IWC) emphasized the need to estimate the probability of a WNP gray whale being struck during aboriginal gray whale hunts (IWC 2012). Additionally, NOAA is required by the National Environmental Policy Act (NEPA) to prepare an Environmental Impact Statement (EIS) pertaining to the Makah's request. The EIS needs to address the likelihood of a WNP whale being taken during the proposed Makah gray whale hunt.

To estimate the probability that a WNP whale might be taken during the proposed Makah gray whale hunt, four alternative models were evaluated. These models made different assumptions about the proportion of WNP whales that would be available for the hunt or utilized different types of data to inform the probability of a WNP whale being taken (Moore and Weller 2013). Based on the preferred model, the probability of striking at least one WNP whale in a single year was estimated to range from 0.006 – 0.012 across different scenarios for the annual number of total gray whales that might be struck. This corresponds to an expectation of ≥ 1 WNP whale strike in one of every 83 to 167 years.

HABITAT CONCERNS

Near shore industrialization and shipping congestion throughout the migratory corridors of the WNP gray whale stock represent risks by increasing the likelihood of exposure to pollutants and ship strikes as well as a general degradation of the habitat. In addition, the summer feeding area off Sakhalin Island is a region rich with offshore oil and gas reserves. Two major offshore oil and gas projects now directly overlap or are in near proximity to this important feeding area, and more development is planned in other parts of the Okhotsk Sea that include the migratory routes of these whales. Operations of this nature have introduced new sources of underwater noise, including seismic surveys, increased shipping traffic, habitat modification, and risks associated with oil spills (Weller et al. 2002). During the past decade, a Western Gray Whale Advisory Panel, convened by the International Union for Conservation of Nature (IUCN), has been providing scientific advice on the matter of anthropogenic threats to gray whales in the WNP (see http://www.iucn.org/wgwap/). Ocean acidification could reduce the abundance of shell-forming organisms (Fabry et al. 2008, Hall-Spencer et al. 2008), many of which are important in the gray whales' diet (Nerini 1984).

STATUS OF STOCK

The WNP stock is listed as "Endangered" under the U.S. Endangered Species Act of 1973 (ESA) and is therefore also considered "strategic" and "depleted" under the MMPA. At the time the ENP stock was delisted, the WNP stock was thought to be geographically isolated from the ENP stock. Recent documentation of some whales moving between the WNP and ENP seems to indicate otherwise (Lang 2010; Mate et al. 2011; Weller et al. 2012; Urbán et al. 2013). Other research findings, however, provide continued support for identifying two separate stocks of North Pacific gray whales, including: (1) significant mitochondrial and nuclear genetic differences between whales that feed in the WNP and those that feed in the ENP (LeDuc et al. 2002; Lang et al. 2011), (2) recruitment into the WNP stock is almost exclusively internal (Cooke et al. 2013), and (3) the abundance of the WNP stock remains low while the abundance of the ENP stock grew steadily following the end of commercial whaling (Cooke et al. 2013). As long as the WNP stock remains listed as endangered under the ESA, it will continue to be considered as depleted under the MMPA.

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NATIONAL MARINE FISHERIES SERVICE INSTRUCTION 02-204-01
February 22, 2016

Protected Resources Management
Marine Mammal Protection Act -- Procedures

GUIDELINES FOR PREPARING STOCK ASSESSMENT REPORTS PURSUANT TO THE 1994 AMENDMENTS TO THE MMPA

NOTICE: This publication is available at: http://www.nmfs.noaa.gov/op/pds/index.html

OPR: F/PR (N. LeBoeuf) **Certified by:** F/PR (D. Wieting)
Type of Issuance: Revised February 2016

SUMMARY OF REVISIONS:
Revised based largely upon recommendations of the 2011 GAMMS III workshop. See section 5 for an overview of revisions.

Signed Donna S. Wieting FEB 19 2016
[Donna S. Wieting] Date
[Director, NMFS Office of Protected Resources]

Guidelines for Preparing Stock Assessment Reports Pursuant to Section 117 of the Marine Mammal Protection Act

1. General Guidelines

Introduction

Section 117 of the Marine Mammal Protection Act (MMPA) requires that the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) develop Stock Assessment Reports (Reports) for all marine mammal stocks in waters under U.S. jurisdiction (U.S. waters). These Reports are to be based upon the best scientific information available. Reports are not required for stocks that have a remote likelihood of occurring regularly in U.S. waters (e.g., stocks for which only the margins of the range extend into U.S. waters or that enter U.S. waters only during anomalous current or temperature shifts).

The MMPA requires Reports to include, among other things, information on how stocks were identified, a calculation of Potential Biological Removal (PBR), and an assessment of whether incidental fishery takes are "insignificant and approaching zero mortality and serious injury rate," as well as other information relevant to assessing stocks. These reports are to be reviewed annually for "strategic stocks" and stocks for which significant new information is available, and at least once every three years for all other stocks. This document provides guidance for how these topics are to be addressed in the Reports.

The MMPA provides some general guidance for developing the Reports. More detailed guidelines were developed at a PBR workshop in June 1994 and were used in writing the original draft Reports. The draft guidelines and initial draft Reports were subjected to public review and comment in August 1994. Final guidelines and Reports were completed in 1995 (Barlow et al. 1995). In 1996, representatives of NMFS, FWS, regional Scientific Review Groups, and the Marine Mammal Commission reviewed the guidelines and proposed minor changes, which after public review and comment, were made final in 1997 (Wade and Angliss 1997). The guidelines were officially updated again in 2005, following a similar revision process beginning with workshop in September 2003 (NMFS 2005). In February 2011, NMFS again convened representatives of the review groups and agencies to review and, as appropriate, recommend revisions to the guidelines. Those recommended revisions (Moore and Merrick 2011) were made available for public review and comment, and are finalized here.

It is anticipated that the guidelines themselves will be reviewed and changed based on additional scientific research and on experience gained in their application. In this regard, FWS and NMFS will meet periodically to review and revise, as needed, the guidelines. When the agencies recommend revisions to the guidelines, these revisions will be made available for public review and comment prior to acceptance. Furthermore, the guidelines in this document do not have to be followed rigidly; however, any departure from these guidelines must be discussed fully within any affected Report.

The intent of these guidelines is to: (1) provide a uniform framework for the consistent application of the amended MMPA throughout the country; (2) ensure that PBR is calculated in a manner that ensures meeting the goals of the MMPA; (3) provide guidelines for evaluating whether fishery takes are insignificant and approaching a zero mortality and serious injury rate; and (4) make the Federal government's approach clear and open to the public. Where the guidelines provided here are not incorporated into a particular Report, justification for the departure will be provided within the Report. Similarly, the Reports will explain when deviations are made from specific recommendations from the Scientific Review Groups.

The FWS and NMFS interpret the primary intent of the 1994 MMPA amendments and the PBR guidelines developed pursuant to the Act as a mechanism to respond to the uncertainty associated with assessing and reducing marine mammal mortality from incidental fisheries takes. Accordingly, this mechanism is increasingly conservative under increasing degrees of uncertainty. The MMPA requires the calculation of PBR for all stocks, including those that are considered endangered or threatened under the Endangered Species Act (ESA) and those that are managed under other authorities, such as the International Whaling Commission. However, in some cases allowable takes under these other authorities may be less than the PBR calculated under the MMPA owing to the different degrees of "risk" associated with, and the treatment of, uncertainty under each authority. Where there is inconsistency between the MMPA and ESA regarding the take of listed marine mammals, the more restrictive mortality requirement takes precedence. Nonetheless, PBR must still be calculated for these stocks, where possible, and discussed in the text of the Reports. As directed in the MMPA, the PBR is calculated as "...the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population." Therefore, a PBR is an upper limit to removals that does not imply that the entire amount should be taken.

Section 117 requires PBR, human-caused mortality, and classification as to whether a stock is "strategic" or "non-strategic" to be included in the Reports for all stocks of marine mammals in U.S. waters. However, it should be noted that the co-management, between the Federal government and Alaska Native Organizations, of removals of marine mammals for subsistence purposes between the Federal government and Alaska Native organizations is specifically addressed in Section 119. In response to Section 119, NMFS and FWS have entered into cooperative agreements with Alaska Native Organizations to conserve marine mammals and provide co-management of subsistence use by Alaska Natives. FWS and NMFS believe that it is appropriate to develop management programs for stocks subject to subsistence harvests through the co-management process provided that commercial fisheries takes are not significant and that the process includes a sound research and management program to identify and address uncertainties concerning the status of these stocks. Calculations of PBR and classification as to whether a stock is strategic will be determined from the analysis of scientific and other relevant information discussed during the co-management process.

In the sections of the Reports on Stock Definition and Geographic Range, elements of the PBR formula, Population Trend, and Annual Human-caused Mortality and Serious Injury, authors are to provide a brief description of key uncertainties in each element and evaluate the effects of these uncertainties associated with parameters in these sections. In cases where more lengthy discussions of uncertainty are necessary, they should be published separately (e.g., as NOAA Technical Memorandum) and referenced in the SAR.

Definition of "Stock"

"Population stock" is the fundamental unit of legally-mandated conservation. The MMPA defines population stock as "a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature." To fully interpret this definition, it is necessary to consider the objectives of the MMPA. Section 2 (Findings and Declaration of Policy) of the MMPA states that "...species and population stocks of marine mammals...should not be permitted to diminish beyond the point at which they cease to be a significant functioning element in the ecosystem of which they are a part, and, consistent with this major objective, they should not be permitted to diminish below their optimum sustainable population." Further, it states "...the primary objective of their management should be to maintain the health and stability of the marine ecosystem. Whenever consistent with this primary objective, it should be the goal to obtain an optimum sustainable population keeping in mind the carrying capacity of the habitat." Therefore, stocks must be identified in a manner that is consistent with these goals. For the purposes of management under the MMPA, a stock is recognized as being a management unit that identifies a demographically independent biological population. It is recognized that in practice, our ability to detect stocks may fall short of this ideal because of a lack of information, or for other reasons.

Many types of information can be used to identify stocks of a species (e.g., distribution and movements, population trends, morphology, life history, genetics, acoustic call types, contaminants and natural isotopes, parasites, and oceanographic habitat). Different population responses (e.g., different trends in abundance) between geographic regions are also an indicator of stock structure, as populations with different trends are not strongly linked demographically. When different types of evidence are available to identify stock structure, the Report must discuss inferences made from the different types of evidence and how these inferences were integrated to identify the stock.

Evidence of morphological or genetic differences in animals from different geographic regions indicates that these populations are demographically independent. Demographic independence means that the population dynamics of the affected group is more a consequence of births and deaths within the group (internal dynamics) rather than immigration or emigration (external dynamics). Thus, the exchange of individuals between population stocks is not great enough to prevent the depletion of one of the populations as a result of increased mortality or lower birth rates.

Failure to detect genetic or morphological differences, however, does not necessarily mean that populations are not demographically independent. Dispersal rates, though sufficiently high to homogenize morphological or genetic differences detectable between putative populations, may still be insufficient to deliver enough recruits from an unexploited population (source) to an adjacent exploited population (sink) so that the latter remains a functioning element of its ecosystem. Insufficient dispersal between populations where one bears the brunt of exploitation coupled with their inappropriate pooling for management could easily result in failure to meet

MMPA objectives. For example, it is common to have human-caused mortality restricted to a portion of a species' range. Such concentrated mortality (if of a large magnitude) could lead to population fragmentation, a reduction in range, or even the loss of undetected populations, and would only be mitigated by high immigration rates from adjacent areas.

Therefore, careful consideration needs to be given to how stocks are identified. In particular, where mortality is greater than a PBR calculated from the abundance just within the oceanographic region where the human-caused mortality occurs, serious consideration should be given to identifying an appropriate management unit in this region. In the absence of adequate information on stock structure and fisheries mortality, a species' range within an ocean should be divided into stocks that represent defensible management units. Examples of such management units include distinct oceanographic regions, semi-isolated habitat areas, and areas of higher density of the species that are separated by relatively lower density areas. Such areas have often been found to represent true biological stocks where sufficient information is available. In cases where there are large geographic areas from which data on stock structure of marine mammals are lacking, stock structure from other parts of the species' range may be used to draw inferences as to the likely geographic size of stocks. There is no intent to identify stocks that are clearly too small to represent demographically independent biological populations, but it is noted that for some species genetic and other biological information has confirmed the likely existence of stocks of relatively small spatial scale, such as within Puget Sound, WA, the Gulf of Maine, or Cook Inlet, AK.

Each Report will state in the Stock Definition and Geographic Range section whether it is plausible the stock contains multiple demographically independent populations that should be separate stocks, along with a brief rationale. If additional structure is plausible and human-caused mortality or serious injury is concentrated within a portion of the range of the stock, the Report should identify the portion of the range in which the mortality or serious injury occurs. In addition, a description of any additional key uncertainties concerning the stock definition should be provided, along with an evaluation of the potential effects of these uncertainties on the stock definition.

In transboundary situations where a stock's range spans international boundaries or the boundary of the U.S. Exclusive Economic Zone (EEZ), the best approach is to establish an international management agreement for the species and to evaluate all sources of human-caused mortality and serious injury (U.S. and non-U.S.) relative to the PBR for the entire stock range. In the interim, if a transboundary stock is migratory and it is reasonable to do so, the fraction of time the stock spends in U.S. waters should be noted, and the PBR for U.S. fisheries should be apportioned from the total PBR based on this fraction. For non-migratory transboundary stocks (e.g., stocks with broad pelagic distributions that extend into international waters), if there are estimates of mortality and serious injury from U.S. and other sources throughout the stock's range, then PBR calculations should be based upon a range-wide abundance estimate for the stock whenever possible. In general, abundance or density estimates from one area should not be extrapolated to unsurveyed areas to estimate range-wide abundance (and PBR). But, informed interpolation (e.g., based on habitat associations) may be used to fill gaps in survey coverage and estimate abundance and PBR over broader areas as appropriate and supported by existing data.[1] If estimates of mortality or abundance from outside the U.S. EEZ cannot be determined, PBR calculations should be based on abundance within the EEZ and compared to mortality within the EEZ.

Prospective Stocks

When information becomes available that appears to justify a different stock structure or stock boundaries, it may be desirable to include the new structure or boundaries as "prospective stocks" within the existing Report. The descriptions of prospective stocks would include a description of the evidence for the new stocks, calculations of the prospective PBR for each new stock, and estimates of human-caused mortality and serious injury, by source. The notice of availability of draft Reports with prospective stocks would include a request for public comment and additional scientific information specifically addressing the prospective stock structure. Prospective stocks would be expected to become separate stocks in a timely manner unless additional evidence was produced to contradict the prospective stock structure. Summary information for prospective stocks should be included in the standard table in the Reports that summarizes the minimum population estimate, the maximum net productivity rate, etc. for each stock.

PBR Elements

The 1994 amendments to the MMPA mandate that, as part of the Reports, PBR must be calculated for each marine mammal stock in U.S. waters. The PBR is defined as "the maximum number of animals, not including natural mortality, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population." In addition, the MMPA states that PBR is calculated as the product of three elements: the minimum population estimate (N_{min}); half the maximum net productivity rate (0.5 R_{max}); and a recovery factor (F_r). The guidelines for defining and applying each of these three elements are described below. Further specific guidance on the calculation of PBR is provided in part 2 (Technical Details) of this document. The Report should provide a description of any key uncertainties in the elements of the PBR equation and evaluate the effects of these uncertainties on the estimate.

An underlying assumption in the application of the PBR equation is that marine mammal stocks exhibit certain population dynamics. Specifically, it is assumed that a depleted stock will naturally grow toward OSP and that some surplus growth may be removed while still allowing recovery. There are unusual situations, however, where the formula Congress added to the MMPA to calculate PBR ($N_{min}*0.5R_{max}*F_r$) results in a number that is not consistent with the narrative definition of PBR (the maximum number of animals, not including natural mortality, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its OSP). That is, there are situations where a stock is below its OSP and is declining or stable, yet human-caused mortality is a not a major factor in the population's trend. Thus, for

[1] "Informed interpolation" specifically refers to the use of a model-based method for interpolating density between transect lines, such as habitat-based density modeling and other forms of spatial modeling.

unknown reasons, the stock's population dynamics do not conform to the underlying model for calculating PBR. In such unusual situations, the PBR calculations should be qualified in the Report in the PBR section.

Minimum Population Estimate (N_{min})

N_{min} is defined in the MMPA amendments as an estimate of the number of animals in a stock that:

> "(A) is based on the best available scientific information on abundance, incorporating the precision and variability associated with such information; and,
>
> "(B) provides reasonable assurance that the stock size is equal to or greater than the estimate."

Consistent with these MMPA definitions, N_{min} should be calculated such that a stock of unknown status would achieve and be maintained within OSP with 95% probability. Population simulations have demonstrated (Wade 1994) that this goal can be achieved by defining N_{min} as the 20th percentile of a log-normal distribution based on an estimate of the number of animals in a stock (which is equivalent to the lower limit of a 60% 2-tailed confidence interval):

$$N_{min} = N/\exp(0.842 * (\ln(1+CV(N)^2))^{1/2})$$

where N is the abundance estimate and CV(N) is the coefficient of variation of the abundance estimate. If abundance estimates are believed to be biased, appropriate correction factors should be applied to obtain unbiased estimates of N. In such cases, the coefficient of variation for N should include uncertainty in the estimation of the correction factor. In cases where a direct count is available, such as for many pinniped stocks, this direct count could alternatively be used as the estimate of N_{min}. Other approaches could also be used to estimate N_{min} if they provide the same level of assurance that the stock size is equal to or greater than that estimate.

Clearly, the most recent abundance estimate becomes a less accurate population descriptor with time. When abundance estimates become many years old, at some point estimates will no longer meet the requirement that they provide reasonable assurance that the stock size is presently greater than or equal to that estimate. Therefore, unless compelling evidence indicates that a stock has not declined since the last census, the N_{min} estimate of the stock should be considered unknown if 8 years have transpired since the last abundance survey. Eight years was chosen, in part, because a population that declines at 10% per year from carrying capacity would be reduced to less than 50% of its original abundance after 8 years. A 10% decline per year over at least 8 years represents the greatest decline observed for a stock of marine mammals in U.S. waters. If N_{min} is unknown, then PBR cannot be determined, but this is not equivalent to considering PBR equal to zero. If there is known or suspected human-caused mortality of the stock, decisions about whether such stocks should be declared strategic or not should be made on a case-by-case basis. Stocks for which N_{min} becomes unknown should not move from "strategic" to "not-strategic", or v.v., solely because of an inability to estimate N_{min}.

Population Trend

The Reports will describe information on current population trend. The Report should also provide a description of any key uncertainties concerning the population trend, and evaluate the effects of these uncertainties on the trend.

Maximum Rate of Increase (R_{max})

One-half R_{max} is defined in the MMPA as "one-half of the maximum theoretical or estimated "net productivity rate of the stock at a small population size," where the term "net productivity rate" means "the annual per capita rate of increase in a stock resulting from additions due to reproduction, less losses due to natural mortality." Default values should be used for R_{max} in the absence of stock-specific measured values. To be consistent with a risk-averse approach, these default values should be near the lower range of measured or theoretical values (or 0.12 for pinnipeds and sea otters and 0.04 for cetaceans and manatees). Substitution of other values for these defaults should be made with caution, and only when reliable stock-specific information is available on R_{max} (e.g., estimates published in peer-reviewed articles or accepted by review groups such as the MMPA Scientific Review Groups or the Scientific Committee of the International Whaling Commission).

Details on rounding and precision, and on averaging more than one estimate of abundance to calculate N_{min}, can be found in part 2 (Technical Details) of this document.

Recovery Factor (F_r)

The MMPA defines the recovery factor, F_r, as being between 0.1 and 1.0. The intent of Congress in adding F_r to the definition of PBR was to ensure the recovery of populations to their OSP levels, and to ensure that the time necessary for populations listed as endangered, threatened, and/or depleted to recover was not significantly increased. The use of F_r less than 1.0 allocates a proportion of expected net production towards population growth and compensates for uncertainties that might prevent population recovery, such as biases in the estimation of N_{min} and R_{max} or errors in the determination of stock structure. Population simulation studies (Barlow et al. 1995, Wade 1998) demonstrate that the default F_r for stocks of endangered species should be 0.1, and that the default F_r for depleted and/or threatened stocks and stocks of unknown status should be 0.5.

The default status should be considered as "unknown." Stocks known to be within OSP (e.g., as determined from quantitative methods such as dynamic response or back-calculation), or stocks of unknown status that are known to be increasing, or stocks that are not known to be decreasing taken primarily by aboriginal subsistence hunters, could have higher F_r values, up to and including 1.0, provided there have not been recent increases in the levels of takes. Recovery factors for ESA-listed stocks can be changed from their default values, but only after careful consideration and where available scientific evidence confirms that the stock is not in imminent danger of extinction. Values other than the defaults for any stock should usually not be used without the approval of the regional Scientific Review Group, and scientific justification for the change should be provided in the Report.

The recovery factor can be adjusted to accommodate additional information and to allow for management discretion as appropriate and consistent with the goals of the MMPA. For example, if human-caused mortalities include more than 50% females, the recovery factor should be decreased to compensate for the greater impact of this mortality on the population (or increased if less than 50% female). Similarly, declining stocks, especially ones that are threatened or depleted, should be given lower recovery factors, the value of which should depend on the magnitude and duration of the decline. The recovery factor of 0.5 for threatened or depleted stocks or stocks of unknown status was determined based on the assumption that the coefficient of variation of the mortality estimate is equal to or less than 0.3. If the CV is greater than 0.3, the recovery factor should be decreased to: 0.48 for CVs of 0.3 to 0.6; 0.45 for CVs of 0.6 to 0.8; and 0.40 for CVs greater than 0.8.

Recovery factors could also be increased in some cases. If mortality estimates are known to be relatively unbiased because of high observer coverage, then it may be appropriate to increase the recovery factor to reflect the greater certainty in the estimates. Thus, in an instance where the observer coverage was 100% and the observed fishery was responsible for virtually all fishery mortality on a particular stock, the recovery factor for a stock of unknown status might be increased from 0.5 (reflecting less concern about bias in mortality, but continued concern about biases in other PBR parameters and errors in determining stock structure). Recovery factors of 1.0 for stocks of unknown status should be reserved for cases where there is assurance that N_{min}, R_{max}, and the estimates of mortality and serious injury are unbiased and where the stock structure is unequivocal.

Annual Human-caused Mortality and Serious Injury

A summary of all human-caused mortality and serious injury should be provided in each Report as the first paragraph under "Annual human-caused mortality and serious injury." This summary should include information on all mortality and serious injury (e.g., U.S. commercial fishing, other fishery mortality from recreational gear and foreign fleets, strandings, vessel strikes, power plant entrainment, shooting, scientific research, after-action reports from otherwise authorized activities, etc.).

The Reports should contain a complete description of what is known about current human-caused mortality and serious injury. Information about incidental fisheries mortality should be provided, including sources such as observer programs, logbooks, fishermen's reports, strandings, and other sources, where appropriate. It is expected that this section of the Reports will include all pertinent information that is subsequently used to categorize fisheries under Section 118. Therefore, any additional information that is anticipated to be used to categorize a fishery should be provided here.

If mortality and serious injury estimates are available for more than one year, a decision will have to be made about how many years of data should be used to estimate annual mortality. There is an obvious trade-off between using the most relevant information (the most recent data) versus using more information (pooling across a number of years) to increase precision and reduce small-sample bias. It is inappropriate to state specific guidance directing which years of data should be used, because the case-specific choice depends upon the quality and quantity of data. Accordingly, mortality estimates could be averaged over as many years as necessary to achieve statistically unbiased estimation with a CV of less than or equal to 0.3. Generally, estimates include the most recent five years for which data have been analyzed, as this accounts for inter-annual variability. However, information more than five years old can be used if it is the most appropriate information available in a particular case.

In some cases it may not be appropriate to average over as many as five years even if the CV of an estimate is greater than 0.3. For example, if within the last five years the fishery has changed (e.g., fishing effort or the mortality rate per unit of fishing effort has changed), it would be more appropriate to use only the most recent relevant data to most accurately reflect the current level of annual mortality. When mortality is averaged over years, an un-weighted average should be used, because true mortality rates vary from year-to-year. When data are insufficient to overcome small-sample bias of mortality estimates for purposes of comparing the estimates to PBR (see Technical Details), a statement acknowledging this elevated potential for small-sample bias should accompany mortality estimates in the Reports.

In some cases, mortality and serious injury occur in areas where more than one stock of marine mammals occurs. When biological information (e.g., photo-identification, genetics, morphology) is sufficient to identify the stock from which a dead or seriously injured animal came, then the mortality or serious injury should be associated only with that stock. When one or more deaths or serious injuries cannot be assigned directly to a stock, then those deaths or serious injuries may be partitioned among stocks within the appropriate geographic area, provided there is sufficient information to support such partitioning (e.g., based on the relative abundances of stocks within the area). When the mortality and serious injury estimate is partitioned among overlapping stocks, the Reports will contain a discussion of the potential for over- or under-estimating stock-specific mortality and serious injury. In cases where mortality and serious injuries cannot be assigned directly to a stock and available information is not sufficient to support partitioning those deaths and serious injuries among stocks, the total unassigned mortality and serious injuries should be assigned to each stock within the appropriate geographic area. When deaths and serious injuries are assigned to each overlapping stock in this manner, the Reports will contain a discussion of the potential for over-estimating stock-specific mortality and serious injury.

A summary of mortality and serious injury incidental to U.S. commercial fisheries should be presented in a table, providing the name of the fishery and, for each appropriate year, observed mortality and serious injury, estimated extrapolated mortality and serious injury and associated CV, and percent observer coverage in that year, with the last column providing the average annual mortality and serious injury estimate for that fishery. Information on non-serious injuries should also be provided, either in the table or the text.[2] Because U.S. commercial fisheries and foreign fisheries within the U.S. EEZ are subject to regulation under MMPA Section 118, mortality and serious injury from such fisheries should be clearly separated from other fishery-related mortality (e.g., mortality incidental to recreational fishing or foreign fishing beyond the U.S. EEZ) in the Reports.

There is a general view that marine mammal mortality information from logbook or fishermen's report data can only be considered as a minimum estimate of mortality, although exceptions may occur. Logbook or fishermen's report information can be used to determine whether the minimum mortality is greater than the PBR (or greater than 10% of the PBR), but it should not be used to determine whether the mortality is less than the PBR (or 10% of the PBR). Logbook data for fishermen's reports should not be used as the sole justification for determining that a particular stock is not strategic or that its mortality and serious injury rate is insignificant and approaching zero.

For fisheries without observer programs, information about incidental mortality and serious injury from logbooks, fishermen's self-reports, strandings, and other sources should be included where appropriate. When these other sources of data are used, particularly as a significant component of the measure of annual human-caused mortality, the following language should be added to the Report: "It is important to stress that this mortality estimate results from an actual count of verified human-caused deaths and serious injuries and should be considered a minimum." Such information should be presented in brackets to distinguish it from estimates of total mortality and serious injury in the fishery. If such information is not included in the table, but reports such as fishermen's self-reports are available, those reports should be described in the text and any concern with the quality of that report should be noted. Fishermen's self-reports of mortality or injuries should not be included if the fishery was observed and incidental mortality and serious injury was estimated based on observer records and associated coverage. Mortality and serious injury by those fisheries not regulated under MMPA Section 118 (i.e., incidental to foreign fisheries or recreational fisheries), should be distinguished from mortality and serious injury incidental to fisheries subject to Section 118. Further guidance on averaging human-caused mortality across years and across different sources of mortality can be found in the Technical Details section of these guidelines.

Because many stocks are subject to human caused mortality or serious injury that is unmonitored or not fully quantified, authors of the Reports should add a sub-section of the Human-Caused Mortality and Serious Injury section to include a summary of the most prevalent potential sources of human-caused mortality or serious injury that are not quantified (e.g., fisheries that have never been observed, or have not been observed recently, and ship strikes). If there are no major known sources of unquantifiable human-caused mortality or serious injury, this should be explicitly stated. Finally, a description of any additional key uncertainties concerning human-caused mortality or serious injury should be provided, along with an evaluation of the potential effects of these uncertainties on the mortality estimates.

[2] In 2012, NMFS implemented a policy to distinguish serious from non-serious injuries (NOAA 2012). This policy and associated procedural directive detail the process by which NMFS evaluates injuries, documents that rationale, and reviews determinations.

Mortality Rates

Section 118 of the 1994 MMPA Amendments reaffirmed the goal set forth in the Act when it was enacted in 1972 that the take of marine mammals in commercial fisheries is to be reduced to insignificant levels approaching zero mortality and serious injury rate, and further requires that this goal be met within seven years of enactment of the 1994 Amendments (April 30, 2001). This fisheries-specific goal is referred to as the "zero mortality rate goal" (ZMRG). The Reports are not the vehicle for publishing determinations as to whether a specific fishery has achieved the ZMRG. A review of progress towards the ZMRG for all fisheries was submitted to Congress in August 2004.

However, Section 117 of the amended MMPA requires that Reports include descriptions of fisheries that interact with (i.e., kill or seriously injure) marine mammals, and these descriptions must contain "an analysis stating whether such level is insignificant and is approaching a zero mortality and serious injury rate." As a working definition for the Reports, this analysis should be based on whether the total mortality for a stock in all commercial fisheries with which it interacts is less than 10% of the calculated PBR for that stock. The following wording is recommended (typically in the "Status of Stock" section of the Report):

"The total fishery mortality and serious injury for this stock is (or is not) less than 10% of the calculated PBR and, therefore, can (or cannot) be considered to be insignificant and approaching a zero mortality and serious injury rate."

Status of Stocks

This section of the Reports should present a summary of four types of "status" of the stock: (1) current legal designation under the MMPA and ESA, (2) status relative to OSP (within OSP, below OSP, or unknown), (3) designation of strategic or non-strategic, and (4) a summary of trends in abundance and mortality. Based upon descriptions of levels of uncertainties from the Report sections on Stock Definition and Geographic Range, Elements of the PBR Formula, Population Trend, and Annual Human-Caused Mortality and Serious Injury, authors should evaluate and describe any consequences of these uncertainties on the assessment of the stock's status.

Stocks that have evidence suggesting at least a 50% decline, either based on previous abundance estimates or historical abundance estimated by back-calculation, should be noted in the Status of Stocks section as likely to be below OSP. The choice of 50% does not mean that the lower bound of a stock's OSP range is at 50% of historical numbers, but rather that a population below this level would be below OSP with high probability. However, without further analysis and completions of requirements laid out in Section 115, determination of stock status with regard to whether or not it is depleted (or, by extension, strategic based on depleted status) cannot be made. Similarly, a stock that has increased back to levels pre-dating the known decline may be within OSP; however, additional analyses may determine a population is within OSP prior to reaching historical levels.

Section 3(19) of the MMPA defines the term "strategic stock" as a marine mammal stock: (A) for which the level of direct human-caused mortality exceeds the potential biological removal level; (B) based on the best available scientific information, is declining and is likely to be listed as a threatened species under the Endangered Species Act of 1973 [16U.S.C. 1531 et seq.] within the foreseeable future; or (C) which is listed as a threatened species or endangered species under the ESA or is designated as depleted under the MMPA.

The MMPA requires a determination of a stock's status as being either strategic or non-strategic and does not include a category of unknown. If abundance or human-related mortality levels are truly unknown (or if the fishery-related mortality level is only available from self-reported data), some judgment will be required to make this determination. If the human-caused mortality is believed to be small relative to the stock size based on the best scientific judgment, the stock could be considered as non-strategic. If human-caused mortality is likely to be significant relative to stock size (e.g., greater than the annual production increment) the stock could be considered as strategic. Likewise, trend monitoring can help inform the process of determining strategic status.

The MMPA requires for strategic stocks a consideration of other factors that may be causing a decline or impeding recovery of the stock, including effects on marine mammal habitat and prey. In practice, interpretation of "other factors" may include lethal or non-lethal factors other than effects on habitat and prey. Therefore, such issues should be summarized in the Status of Stock section for all strategic stocks. If substantial issues regarding the habitat of the stock are important, a separate section titled "Habitat Issues" should be used. If data exist that indicate a problem, they should be summarized and included in the Report. If there are no known habitat issues or other factors causing a decline or impeding recovery, this should be stated in the Status of Stock section.

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Williams, R, Gero, S, Bejder, L, Calambokidis, J, Kraus, SD, Lusseau, D, Read, A, and Robbins, J. 2011. Underestimating the damage: interpreting cetacean carcass recoveries in the context of the Deepwater Horizon/BP incident. Conservation Letters 4(3)228-233.

2. Technical Details

In this section, technical details are given for making appropriate calculations of PBR and mortality. The first section provides details on precision and rounding issues. The second section provides details for combining more than one abundance estimate for calculating N_{min}. The third section contains details for calculating the estimate of annual human caused mortality and its associated variance.

Precision and Rounding

The following rules on precision and rounding should be applied when calculating PBR and other values:

(a) N (the abundance estimate), CV(N), R_{max}, and F_r should be reported in the Report to whatever precision is thought appropriate by the authors and involved scientists, so long as what is reported is exactly what the PBR calculation is based on.
(b) PBR should be calculated from the values for (a) to full precision, and not be calculated from an intermediary rounded off N_{min}. However, N_{min} should be reported as a rounded integer.
(c) PBR and mortality should be reported with one decimal place if they are below 10. Otherwise, PBR and mortality should be reported as a rounded integer.
(d) If PBR and mortality round to the same integer, the Report will report both values to the precision necessary to determine which is larger. This would also be done if 10% of PBR and mortality round to the same integer.

Computation of Average Abundance and its Variance

When estimates of abundance are available for more than one year or from more than one source in the same year, it may be appropriate to combine those estimates into an average abundance for the time period in question. It was agreed that a weighted mean was probably the most appropriate average to use, where the weights are equal to the inverse of the associated variance:

$$mean(a_1, a_2, ... a_n) = a = \sum_{i=1}^{n} w_i a_i \quad ,$$

where:

$$w_i = \frac{1/var(a_i)}{\sum_{j=1}^{n} 1/var(a_j)} \quad .$$

The variance of a weighted mean of several abundance estimates is calculated as:

$$var(a) = w_1^2 var(a_1) + w_2^2 var(a_2) + ... w_2^2 var(a_n) = \sum_{i=1}^{n} w_i^2 var(a_i) \ .$$

Finally, the variance is parameterized as a CV in the provided equation for calculating N_{min}. The CV is calculated as:

$$CV(a) = \frac{\sqrt{var(a)}}{a}$$

Computation of Average Human-Caused Mortality and its Variance

When estimates of human-caused mortality and serious injury (called here "mortality") are available for more than one year and/or from more than one source, such as a fishery, it is necessary to calculate an estimate of the mean annual mortality along with its associated variance (or CV). The following section provides guidelines for doing this. For convenience, the section refers to averaging the incidental bycatch of fisheries, but the guidelines apply equally well to estimates of human-caused mortality from other sources.

Calculating the overall mean annual bycatch

First, it was agreed that it was most appropriate for the bycatch estimates from a fishery to be averaged UN-WEIGHTED across years, as the true bycatch might be different in each year, and thus is not stationary. This is just the simple average of the available estimates of bycatch. If estimates are available from more than one fishery, a mean annual bycatch from each fishery should be calculated first, and then the annual mean from each fishery should be summed to calculate an overall estimate of the mean annual bycatch.

Calculating the coefficient of variation (CV) of the mean annual bycatch of a single fishery

There are two potential methods for calculating the CV or variance of the mean annual bycatch of a single fishery. Method 1 involves using standard statistical formulas for combining the variances of the individual yearly bycatch estimates (assuming they are available). Method 2 involves estimating the variance empirically from the 2-5 years of point estimates of bycatch, which is done by calculating the standard deviation of the 2-5 mortality estimates and dividing it by the square root of n, where n is the number of years available. Both methods are valid. However, two points favor Method 1.

First, because the true bycatch might be different in each year, and thus is not stationary, estimating the variance using Method 2 above could over-estimate the true variance of the estimates of bycatch, and this positive bias would be related to how much the bycatch truly varied from year to year independent of observation error.

Second, Method 1 is likely to give a more precise estimate of the variance because it has more degrees of freedom. Using Method 2 involves estimating the variance from a sample size of just 2-5, and ignores the information that is known about the precision of each individual estimate.

Obviously, Method 2 is the only method that can be used if there are no estimates of the variance of the bycatch estimates available. Method 1 is the recommended method if the estimates of bycatch in each year do have an estimated variance (or CV).

<u>Method 1</u>
Table 1 outlines the computations needed for estimates of average bycatch mortality by *f* fisheries operating over *n* years. Table 2 gives an example computation for f=3 fisheries operating over a horizon of n=3 years and all of the estimates are non-zero. Most variance estimators will provide an estimate of 0 for the variance when the estimated mortality is zero; however, the true variance is non-zero. In this case, a more realistic estimate of the variance can be developed by averaging the variances for those years which have a positive variance. The variance computations in Table 1 are simply modified by dividing by the square of the number of years with a non-zero variance. The computation of the average is unaffected with the zero included in the average (Table 3). In certain circumstances a fishery may have been operating but was not monitored for mortality. Missing estimates should be dropped both from the calculation of the average and the variance (Table 4).

<u>Method 2</u>
In Method 2 the only change is in how the variance is calculated for the estimate of average bycatch mortality for each fishery over *n* years. In Method 2 the variance of the average bycatch is estimated empirically from the several point estimates of bycatch available from different years. This is done by calculating the variance of those estimates and dividing it by *n*, where *n* is the number of years used in calculating the average:

$$var(m_{i.}) = \frac{\sum_{j=1}^{n} \frac{(m_{ij}-m_{i.})^2}{n-1}}{n} \quad .$$

The above formula would thus be substituted for the formula for $var(m_{1.})$ presented in Table 1. The second step of combining variances across fisheries is identical to Method 1.

Table 1. Computation table for average mortality for *n* years with *f* fisheries. The mortality estimate for fishery *I* during year *j* is m_{ij} and the corresponding variance estimate is v_{ij}. The estimated total mortality for year *j* is $m_{.j}$, the sum of mortality estimates for each fishery and the variance is $v_{.j}$, the sum of the variances. The average mortality for fishery *I* is $m_{I.}$ and its variance is vi., which is the sum of the variances for each year within the fishery divided by the number of years (*n*) squared.

Fishery	Year 1	Year 2 ...	Year *n*	Average
1	m_{11} var(m_{11})	m_{12} var(m_{12})	m_{1n} var(m_{1n})	$m_{1.} = \sum_{j=1}^{n} m_{1j}/n \quad var(m_{1.}) = \sum_{j=1}^{n} var(m_{1j})/n^2$
2 . .	m_{21} var(m_{21})	m_{22} var(m_{22})	m_{2n} var(m_{2n})	$m_{2.} = \sum_{j=1}^{n} m_{2j}/n \quad var(m_{2.}) = \sum_{j=1}^{n} var(m_{2j})/n^2$
f	m_{f1} var(m_{f1})	m_{f2} var(m_{f2})	m_{fn} var(m_{fn})	$m_{f.} = \sum_{j=1}^{n} m_{fj}/n \quad var(m_{f.}) = \sum_{j=1}^{n} var(m_{fj})/n^2$
Total				$m_{..} = \sum_{i=1}^{f} m_{i.} \quad var(m_{..}) = \sum_{i=1}^{f} var(m_{i.})$

Table 2. Example computation of average mortality and its variance for 3 fisheries over 3 years.

		Year			
Fishery		**1**	**2**	**3**	**Average**
1	m	10	3	19	10.67
	v	4	2	8	1.56
2	m	2	13	6	7.00
	v	2	14	4	2.22
3	m	6	33	5	14.67
	v	8	23	4	3.89
Total	m				32.33
	v				7.67

Table 3. Example computation of average mortality and its variance for 3 fisheries over 3 years when some estimates are zero.

		Year			
Fishery		**1**	**2**	**3**	**Average**
1	m	10	0	19	9.67
	v	4	0	8	3.00
2	m	2	13	6	7.00
	v	2	14	4	2.22
3	m	0	0	5	1.67
	v	0	0	4	4.00
Total	m				18.33
	v				9.22

Table 4. Example computation of average mortality and its variance for 3 fisheries over 3 years when some estimates are zero and others are missing.

		Year			
Fishery		**1**	**2**	**3**	**Average**
1	m		0	19	9.50
	v		0	8	8.00
2	m	2		6	4.00
	v	2		4	1.50
3	m	0	0	5	1.67
	v	0	0	4	4.00
Total	m				15.17
	v				13.50

Guidelines for minimum observer sample size requirements
(Avoiding small-sample bias when PBR is small)

Table 6. Recommended data levels to attain approximately unbiased estimation of average annual fisheries-related mortality and serious injury, relative to PBR (i.e., if true annual bycatch = PBR) (from Moore and Merrick 2011). “Approximately unbiased” implies median absolute bias < 25%. The top table recommends minimum observer coverage (annual average), given a certain PBR and level of data pooling (years of information combined). The bottom table recommends minimum levels of data pooling, given a certain PBR and observer coverage. If true bycatch = PBR and sampling effort is below the recommended levels, *median* bias is always negative (i.e., true bycatch > estimate), but the combination of *very* limited sampling (≤5% coverage, ≤ 5 yrs data pooling) and *very* low bycatch (e.g., 1/yr) generates bimodal estimation bias, whereby bycatch is always either underestimated (if no bycatch is observed) or overestimated (if ≥ 1 bycatch event is observed).

	Observer program length (years)								
PBR	1	2	3	4	5	6	7	8	9
1	80%	40%	30%	30%	20%	15%	15%	10%	10%
2	40%	20%	15%	10%	10%	7.5%	7.5%	5%	5%
3	30%	15%	10%	7.5%	7.5%	5%	4%	4%	3%
4	20%	10%	7.5%	5%	4%	4%	3%	3%	3%
5	20%	7.5%	7.5%	4%	4%	3%	3%	2%	2%
6	15%	7.5%	5%	4%	3%	3%	2%	2%	2%
7	15%	7.5%	4%	3%	3%	2%	2%	2%	2%
8	10%	5%	4%	3%	2%	2%	2%	2%	2%
9	10%	5%	3%	3%	2%	2%	2%	2%	1%

Required observer coverage

	Observer coverage											
PBR	1%	2%	3%	4%	5%	7.5%	10%	15%	20%	30%	40 - 70%	80%
1	Always biased	→	→	→	→	→	8	6	4	3	2	1
2	Always biased	→	→	→	8	6	4	3	2	2	1	1
3	Always biased	→	9	7	6	4	3	2	2	1	1	1
4	Always biased	→	7	5	4	3	2	2	1	1	1	1
5	Always biased	8	6	4	4	3	2	2	1	1	1	1
6	Always biased	7	5	4	3	2	2	1	1	1	1	1
7	Always biased	6	4	3	3	2	2	1	1	1	1	1
8	Always biased	5	4	3	2	2	1	1	1	1	1	1
9	9	5	3	3	2	2	1	1	1	1	1	1

Required years of data pooling

3. Descriptions of U.S. Commercial Fisheries

Fisheries table in each stock assessment report

Sample incidental fisheries mortality table to be included in Reports. Each fishery noted as interacting with a stock should be included in the table, even if little information is available. Information on the number of incidental injuries and which injuries should be considered serious should be provided in either the table or the text, if appropriate. See discussion in 5.2 of Wade and Angliss (1997).

Table 7. Summary of incidental serious injury and mortality (SI/M) of stock ___ due to commercial fisheries from 1990 through 1994 and calculation of the mean annual SI/M rate. Mean annual SI/M in brackets represents a minimum estimate from logbooks or MMPA reports.

*Note -- numbers indicated with an asterisk are optional -- different preferences have been expressed in different regions.

Fishery Name [1]	Years	Data Type	Range of Observer Coverage	Observed SI/M (in given yrs.)	Estimated SI/M (in given yrs.)	Mean Annual SI/M
groundfish trawl fishery 1	90-94	obs data	53-74%	13, 13, 15, 4, 9	13, 19, 21, 6, 11	14 (0.32)
groundfish trawl fishery 2	90-94	obs data	33-55%	2, 0, 0, 1, 1	4, 0, 0, 3, 3	2 (0.24)
longline fishery 1	90-94	obs data	23-55%	1, 0, 0, 1, 0	2, 0, 0, 4, 1	1.4 (0.15)
drift gillnet fishery 1	90-91	obs data	4-5%	0, 2	0, 29	14.5 (0.42)
Observer program total						31.9 (0.xx)
set gillnet fishery 1	90-93	log book	n/a	0, 1, 1, 1	n/a	[≥.75]*
set gillnet fishery 2	90-93	log book	n/a	0, 0, 0, 2	n/a	[≥.5]*
longline fishery 2	94	mmap reports	n/a	1	n/a	[≥ 1]*
Minimum total annual mortality						≥ 34.2*

[1]The name should be consistent with fishery names in the List of Fisheries.

General information about a fishery (not stock-specific)

Information to provide

As discussed at the GAMMS workshop, information on U.S. commercial fisheries should be included either within each Report, as an appendix, or as a companion document. Information on U.S. commercial fisheries was collected during the preparation of the Environmental Assessment for the proposed regulations implementing Section 118 (NMFS, 1994). The following information, which was provided for each fishery whenever possible, has direct relevance to managing incidental serious injuries and mortalities of marine mammals:

Fishery name: A description of those fisheries that are classified in Category I or II in the LOF, and those fisheries in Category III that have experienced incidental mortality and serious injury of marine mammals should be provided. The Category of the fishery in the List of Fisheries should be specified in the text.

Number of permit holders: NMFS is required by the MMPA to provide the number of permit holders in each fishery included in the List of Fisheries. Information on the number of permit holders in federal fisheries can often be found in recent amendments to Fishery Management Plans. Information on fisheries that occur within state waters but are managed via an interstate commission may be found in interstate fishery management plans. Information on state fisheries that are managed by individual states can typically be found by contacting the state office responsible for licensing commercial fishing vessels.

Number of active permit holders: Because not all licensed commercial fishers participate actively in each fishery, the number of active permit holders may be different than the number of actual permit holders in a fishery. This is particularly true for fisheries that operate in state waters.

Total effort: Provide an estimate of the total fishing effort, in the number of hours fished, for each fishery. This information is typically available only for fisheries that are both federally managed and observed.

Geographic range: Provide a description of the geographic range of the fishery. The description of the geographic range of the fishery should include any major seasonal changes in the distribution of the fishing effort.

Seasons: Describe the seasons during which the fishery operates.

Gear type: Describe the gear type used in the fishery as specifically as possible. Include mesh size, soak duration, trawl type, depth of water typically fished, etc. if the information is available.

Regulations: Indicate whether the fishery is managed through regulations issued by the federal government, interstate fishery commissions, individual states, or treaty.

Management type: Indicate what types of fishery management techniques are used to manage the fishery. Some examples include limited entry, seasonal closures, and gear restrictions.

Comments: Include any additional relevant information on the fishery.

4. Additional Recommendations of the GAMMS III Workshop

The following recommendations were made by the participants of the GAMMS III Workshop:

(1) In order to provide the kind of information that is required to answer the question “is it plausible that there are multiple demographically independent population stocks (DIPS) within this stock?” (in the revised Definition of Stock section), it is recommended that a national workshop be held to review and summarize information that is relevant to population structure. The workshop should include participation from Headquarters and all Centers and Regions, at a minimum. It is unlikely that the workshop could feasibly review all stocks in all areas. Therefore, a list of priority stocks for consideration should be established prior to the workshop. This might efficiently be done by a Steering Committee with stocks to be reviewed proposed from each region. Stocks should be selected to cover a broad range of geographic and taxonomic diversity (e.g., it might be appropriate to review at least one stock each of phocids, otariids, large whales, delphinids, phocoenids, and ziphiids in each region (if presently recognized). Priority should be given to stocks that are geographically large, span multiple bioregions, or potentially experience substantial human-caused mortality in a portion of their range. It would also be appropriate to examine areas of U.S. waters where stocks have not previously been defined (e.g., Guam, Caribbean). The information to be reviewed should include (at least) all information used for defining stocks as recommended in the Guidelines. This includes distribution and movements, acoustic call types, population trends, morphological differences, differences in life history, genetic differences, contaminants and natural isotope loads, parasite differences, and oceanographic habitat differences (such as marine bioregions). It should be emphasized that the purpose of the workshop is to review and summarize relevant information. As possible and appropriate, the workshop will propose revisions to stock structure. A major objective will be to review the information for these stocks in a manner to provide a template for how to complete review of all stocks in each region.

(2) To recognize that the population dynamics of some stocks (such as Cook Inlet beluga and Hawaiian monk seal) may not conform with the underlying assumptions on which the PBR calculation is based (relevant “PBR elements” section of the guidelines), it was recommended that the next administration MMPA reauthorization bill include the explicit option for setting R_{max} (or F_r) to zero in appropriate cases.

(3) A list of regional and F/PR points-of-contact should be created, in order to implement recommendations of Topics 5 and 9 of the GAMMS III workshop pertaining to the timely annual transmission of information on non-serious injury, serious injury, and or death reported under LOAs and IHAs from F/PR to Regional Offices and Science Centers (including to Report authors).

5. Overview of changes from the 2005 Guidelines

The following additions have been made:

- In the stock assessment report (SAR) sections of the Reports on Stock Definition and Geographic Range, elements of the PBR formula, Population Trend, and Annual Human-caused Mortality and Serious Injury, authors are to provide a description of key uncertainties in each element and evaluate their effects;
- Acoustic call type was added as a type of information that can be used to identify stocks;
- Each SAR will state in the Stock Definition and Geographic Range section whether it is plausible the stock contains multiple demographically independent populations that should be separate stocks, along with a brief rationale;
- Informed interpolation may be used to fill gaps in survey coverage;
- A summary of all human-caused mortality should be included in SARs;
- Text regarding avoiding small sample bias was added;
- For mixed stocks, apportion takes among stocks where possible; otherwise, apply take to each stock in area;
- Direction regarding reporting of mortality and serious injury;
- Stocks that have evidence suggesting at least a 50% decline should be noted in the Status of Stocks section as likely to be below their optimum sustainable population level;
- Trend modeling may be used to determine stock status;
- “Other factors” leading to decline or impeding recovery should be considered, including non-lethal factors;
- Added guidelines for minimum observer sample size requirements; and
- Added section on population trends

The following deletions have been made:

- Removed “undetermined” PBR for unusual cases such as Hawaiian monk seal; instead, calculate PBR if possible and qualify in the report;
- Removed statement that default stock status should be strategic; and
- Removed “sources of information on U.S. commercial fisheries” section

The following changes to text/guidance have been made:

- “Demographic isolation” was changed to “demographic independence” and “reproductive isolation” was changed to “reproductive independence”;
- Updated the reference section; and
- Replaced the recommendations from the GAMMS II workshop with recommendations from GAMMS III workshop

International Whaling Commission

Chair's Report of the 64th Annual Meeting

2-6 July 2012

The Red House
135 Station Road, Impington
Cambridge CB24 9NP
United Kingdom

January 2013

SUMMARY OF MAIN OUTCOMES, DECISIONS AND REQUIRED ACTIONS FROM THE 64[TH] ANNUAL MEETING

Issue and Agenda Item	Main outcomes
Sanctuaries *Item 4*	A proposed Schedule amendment to create a South Atlantic Whale Sanctuary was not adopted.
The Future of the IWC *Item 5*	The Commission discussed the future of the IWC in light of the process which had taken place from 2007-2010, and highlighted a range of suggestions for the next steps in the Commission's development.
Status of whale stocks *Item 6* Report of the Scientific Committee (IWC/64/Rep1)	**Antarctic minke whales** • The major re-analysis of two decades of data from the IWC's IDCR and SOWER cruises was completed. Total circumpolar estimates are ~720,000 for 1985/86-1990/91 (CPII) and 515,000 for 1992/93-2003/04 (CPIII). A non-statistically significant decline of about 30% was detected. Work to further investigate this apparent decline continues. **Southern Hemisphere humpback and blue whales** • An in-depth assessment of the status of humpback whale Breeding Stocks E (western South Pacific), F (central South Pacific) and D (western Australia) continues and is expected to be finalised in 2014. The Committee is examining whether sufficient data are available to undertake separate assessments of blue whales by population. **Southern Hemisphere right whales** • An IWC Workshop on the status of Southern Right Whales was held in Buenos Aires in September 2011. Assessment work is on-going and additional analytical and field work has been identified. Invaluable long-term datasets have shown that populations in several areas (southwest Atlantic, southern Africa, Australia) have been recovering. Other populations, e.g. the Chile-Peru population, remain critically endangered. See also Conservation Management Plans below. **Western North Pacific gray whales** • Particular attention was again given to the critically endangered western North Pacific gray whale. A Conservation Management Plan for western North Pacific gray whales has been established. • A two-year telemetry programme undertaken under the auspices of the IWC has found that some whales from the Sakhalin feeding ground on the western North Pacific migrate across to the eastern Pacific; a better understanding of population structure is essential and an IWC-led programme to investigate this is on-going. Continued-operation with the IUCN Western Gray Whale Advisory Panel is important. **North Pacific and North Atlantic right whales and small stocks of bowhead whales** • Grave concern was expressed over these small stocks, where ship strikes and entanglements are important threats. Five deaths and eleven entanglement cases of the endangered western North Atlantic right whale population were reported off the US coast between November 2009 and October 2010 despite welcome on-going mitigation efforts. **North Pacific Research cruises** • A 5-year proposal for the IWC-POWER (North Pacific Ocean Whale and Ecosystem Research) was endorsed; the broad primary objective is to contribute information on abundance and trends in abundance of large whales and to identify the causes of any trends that do occur. The 2012 cruise is underway and the 2013 cruise plan will be finalised intersessionally. Japan, the USA and Korea were thanked and other governments urged to contribute with vessels and/or personnel if possible.

Small cetaceans *Item 19.1* Reports: Scientific Committee (IWC/64/Rep1); Conservation Committee (IWC/64/Rep5)	**Small cetaceans status and review** • The main focus was a review of the ten species of ziphiids in the North Pacific Ocean and the northern Indian Ocean. These populations are not well understood and more research is required. They are especially vulnerable to military sonar and seismic surveys. Effective mitigation is needed and it is strongly recommended that exercises and operations involving use of sonar and seismic equipment should avoid important beaked whale habitat. • Great concern was reiterated over the fears for the extinction of the vaquita and the need for immediate action. Concern was also expressed over: unsustainable bycatches of some populations of harbour porpoises in Europe and franciscana in Brazil; the deliberate killing for bait in the Amazon of botu and tucuxi; and bycatches of the Hector's dolphin in New Zealand. Several governments reported on national actions being taken. **The fund for Small Cetacean Conservation Research** • Progress reports were received on the nine proposals funded last year under the voluntary fund for Small Cetacean Conservation Research. Additional donations to the fund were announced by Italy (€15,000), the Netherlands (€15,000), the UK (£10,000) and a consortium of NGOs (£11,000).
Aboriginal subsistence whaling *Item 7* Reports: Scientific Committee (IWC/64/Rep1), ASW Sub-Committee (IWC/64/Rep3)	• The Commission received a report on the progress towards developing long-term *Strike Limit Algorithms* for the Greenland hunts. • Advice on safe catch limits for at least six years was provided by the Scientific Committee for ASW hunts. Need statements were considered by the ASW Sub-Committee and in the Plenary. • The Commission adopted proposed Schedule amendments for 6-year catch limits for: (1) the Bering-Chukchi-Beaufort Seas stock of bowhead whales; (2) the Eastern stock of gray whales in the North Pacific; and (3) western North Atlantic humpback whales off St. Vincent and The Grenadines. • The Commission did not adopt a proposed Schedule amendment for 6-year catch limits for Greenland hunts. • The Commission received a report on progress made in addressing unresolved ASW issues and approved the recommendations for items considered so far
Ship strikes *Item 8.2* Reports: Scientific Committee (IWC/64/Rep1); Conservation Committee (IWC/64/Rep5)	• A ship strike data co-ordinator will be appointed to further the IWC ship strike database. Given new information on ship strikes from the Arabian Sea and Sri Lanka, the Secretariat will send a letter to the Sri Lankan Government, drawing their attention to the discussion of this topic and ways in which the Commission may assist. Progress reports on mitigation measures were received from a number of countries, including the USA and Panama. • IWC will hold three joint workshops on disentanglement and ship strikes in the wider Caribbean with UNEP and SPAW-RAC in 2012-13. The Secretariat will formalise an agreement with UNEP and SPAW-RAC for collaborative engagement. • The Netherlands and the USA announced their intention to make financial contributions in support of these workshops. • A strategic plan will be developed for addressing the ship strike issue. • A data co-ordinator will be employed so as to increase outreach and use of the IWC ship strike database. • Frédéric Chemay (Belgium) was appointed as Chair of the Ship Strikes Working Group of the Conservation Committee.
Conservation management plans (CMPs) *Item 9* Reports: Scientific Committee (IWC/64/Rep1); Conservation	• CMP guidelines, templates and funding principles were adopted. The Scientific Committee will develop a list of priority candidates for future CMPs and the Conservation Committee will undertake an inventory of cetacean conservation measures in jurisdictions, on a regional basis. • CMPs for the Southwest Atlantic Southern right whale and the Southeast Pacific right whale were adopted. • Progress was reviewed on work towards developing a CMP for the Arabian Sea humpback population. Progress was also reviewed on the existing CMP for Western North Pacific gray whales.

Committee (IWC/64/Rep5)	• A series of recommendations were adopted for cetacean conservation measures in the Pacific Islands Region, with a focus on Oceania humpback whales. The IWC recognised the work of SPREP and invited it to participate as an observer to the IWC's Standing Working Group on CMPs.
Whalewatching *Item 10* Reports: Scientific Committee (IWC/64/Rep1); Conservation Committee (IWC/64/Rep5)	• The 5-year strategic plan for whalewatching was adopted. • Two e*x officio* industry representatives will be added to the Conservation Committee's SWG-WW (Standing Working Group on Whalewatching) • The Secretariat will prepare the following two documents to: (i) outline the options and potential costs for technical support and the creation of an online Handbook; and (ii) the use of 'conservation objectives', to assist the Commission in developing formal conservation objectives for whalewatching against which to monitor the success (or otherwise) of measures taken. • The SWG-WW workplan for the proposed intersessional period of 2012-14 was endorsed.
Other Regular Conservation Committee Items *Item 8* Report of the Conservation Committee (IWC/64/Rep 5)	• The Commission endorsed the Conservation Committee's progress with other on-going areas of work, these being: (1) an investigation of inedible 'stinky' gray whales in the Chukotkan aboriginal subsistence hunt; (2) southern right whales in Chile and Peru; (3) National Reports on cetacean conservation; (4) co-operation with other organisations. • James Gray (UK) was appointed as Vice-Chair of the Conservation Committee.
Whale killing methods and associated welfare issues (WKM&AWI) *Item 11* Report of the WG on WKM&AWI (IWC/64/Rep6)	• The Commission welcomed information from four whaling countries on their operations and one country reported on the euthanasia of stranded animals. • Based on a very successful workshop on welfare issues associated with the entanglement of large whales, the Commission endorsed a global network of entanglement response operations, a set of Principles and Guidelines for Entanglement Response and a recommended approach to capacity building and training including future collaborative work with UNEP-SPAW in the wider Caribbean (and see 'Ship Strikes'). It also agreed a seven step approach for IWC work in this regard. • The USA announced a voluntary contribution of $12,000 towards further work on capacity building for large whale entanglement response. • The Commission agreed future collaborative steps to promoting good animal welfare including: formation of a working group to review the existing Action Plan and develop a workplan for future expert workshops beginning with one on euthanasia; the development of a database of relevant animal welfare science experts; and investigation of co-operation with relevant animal welfare bodies. • The United Kingdom announced a voluntary contribution of £10,000 to support the costs of a workshop to examine euthanasia techniques for large whales. • The World Society for the Protection of Animals announced a voluntary contribution of £3,000 towards the intersessional expenses which would be incurred in undertaking intersessional work on welfare.
Socio-economic implications and small-type whaling *Item 12*	• Japan reiterated its concern over the hardship suffered by its four community-based whaling communities since the implementation of the commercial whaling moratorium. • It introduced an outline proposed Schedule amendment to permit catching of minke whales by small-type whaling vessels. After an exchange of views no consensus was reached and Japan did not ask for further consideration of its Schedule amendment.
The Revised Management Scheme (RMS)	**Revised Management Procedure (RMP)** • The Commission reviewed progress on the Scientific Committee's work on the RMP and related matters which included:

Item 13 Report of the Scientific Committee (IWC/64/Rep1)	o A review of maximum rates of increase of whale stocks and improved guidelines for surveys – these being of broader conservation and management interest, not just the RMP. o The timing of future *Implementation Reviews.* o Progress on the *Implementation Review* for western North Pacific common minke whales (completion expected 2013). o The on-going estimation of bycatch – this is also of broader conservation and management interest than just the RMP and the Commission encouraged continued collection of data where this occurs and initiation of such work where it does not. **RMS** • No work was undertaken on the Revised Management Scheme.
Scientific permits and related issues *Item 14* Report of the Scientific Committee (IWC/64/Rep1)	• The Commission endorsed updated guidelines for the scientific review of new and on-going special permit programmes, especially related to data availability and timing. • The final review of the completed Icelandic programme will occur in 2013. The 6-year review of the JARPA II programme will occur in 2014. • The Republic of Korea announced it may put forward a proposal to undertake special permit whaling of common minke whales in its waters. If so this will need to follow the agreed process for scientific review which has financial implications (see below). • Several countries reiterated their opposition to special permit whaling whilst others reiterated their support.
Safety issues at sea *Item 15*	• Japan drew attention to the violent protest activities against its research vessels in the Southern Ocean during the 2011/12 season. The Commission was again disturbed to receive reports of continuing dangerous activity in the Southern Ocean.
Catches by non-member nations *Item 16* Report of the Scientific Committee (IWC/64/Rep1)	• The Commission was pleased to receive catch data from Canada's bowhead hunt • The Secretary will continue to request information on catches and quotas from Canada. • The Secretary will continue to try to obtain information from the Government of Indonesia on their whale catches.
Infractions *Item 17* Report of the Infractions sub-committee (IWC/64/Rep4)	• The Commission reviewed: o infractions reported in the 2011 and 2011/12 seasons; o follow-up reports from previous years; o information on the domestic surveillance of whaling operations; and o information on the provision of data.
Environmental and health issues **Item** *Item 18* Reports: Scientific Committee (IWC/64/Rep1); Conservation Committee	**Scientific Work** • The Commission reviewed progress on the Scientific Committee's on-going work on environmental concerns including: Phase II of its POLLUTION 2000+ research programme; emerging and resurgent diseases (CERD); anthropogenic sound; climate change; and the State of the Cetacean Environment Report (that focussed on the Indian Ocean). • The importance of improved capacity building and guidelines on oil spill response and prevention were stressed, especially in light of new information received on the 2010 Deepwater Horizon oil spill in the Gulf of Mexico. • Consideration of oils spills will form an important component of a spring 2013 Commission workshop on Anthropogenic Impacts of Cetaceans in the Arctic.

(IWC/64/Rep5)	• The Commission noted the potential and actual threats to cetaceans from marine debris and endorsed a joint Scientific Committee and Conservation Committee workshop on this topic (provisional date April 2013). • The Commission endorsed a general strategy and principles to minimise environmental threats posed by interactions between marine renewable developments (wind farms, tidal stream devices and wave energy converters) and cetaceans. • The importance of the issue of anthropogenic noise was reiterated. Emphasis was placed on further work to identify geographical and species-specific areas of concern, to better understand effects of noise on cetaceans and on collaboration with the International Maritime Organisation on reducing vessel noise. **Resolution** • Resolution 2012-1 was adopted by consensus. It emphasised the importance of scientific research with regard to the impact of the degradation of the marine environment on the health of cetaceans and related human health effects. It will be sent to the World Health Organisation with a request for increased exchange of information between the IWC and the WHO.
Regional non-lethal research partnerships *Item 19.2* Report of the Scientific Committee (IWC/64/Rep1)	• The Commission welcomed intersessional progress with the Southern Ocean Research Partnership which included updates on the existing projects. • Further international involvement in this programme was encouraged. • The reports from a Symposium entitled 'Living whales in the Southern Ocean: advances in methods for non-lethal cetacean research' and four associated workshops held in Chile in March 2012 were also welcomed. • There will be a major multi-year programme entitled the 'Antarctic Blue Whale Project' that emerged from the planning of what had originally been intended to be a Year of the Blue Whale project.
Scientific Committee working methods *Item 19.3* Report of the Scientific Committee (IWC/64/Rep 1)	• The Scientific Committee continued its regular review of its own working methods including adopting methods to reduce costs of Committee meetings, updating its handbook and providing assistance to new members of the Committee. The question of the provision of conservation recommendations for small cetaceans will be considered next year. • The Commission thanked Debi Palka (USA) who had completed her three-year period as Chair of the Scientific Committee. It welcomed Toshihide Kitakado (Japan) the new Chair and Caterina Fortuna (Italy) the new Vice-Chair.
Administration *Item 21* Report of the Finance & Administration Committee (IWC/64/Rep 2)	• The Commission reviewed the F&A Committee's report on application of the Commission's rules regarding quorum, and decided that no action was necessary to update or modify the Rules of Procedure. • The Commission agreed an F&A Committee recommendation to move to biennial (every 2 years) meetings, with the next meeting scheduled for September/October 2014. The Scientific Committee will continue to meet annually. The Commission agreed a series of changes to the Rules of Procedure to enact the change. • Connected with the move to biennial meetings, the Commission also agreed an F&A Committee recommendation to establish a Bureau to guide the progress of the intersessional work programme. • The Commission received the report of the F&A Committee's Working Group on the Role of Observers, and the Chair invited observers organisations to speak after all Contracting Governments on several agenda items. • The Commission welcomed a pre-launch demonstration of the new website, and a number of Contracting Governments submitted comments to allow the website's further development and improvement. • The Commission received the report of the F&A Committee's Working Group on Assistance to Governments of Limited Means, and agreed that the group should continue its work. • The Commission received the report of the F&A Committee's intersessional group on strengthening IWC financing, and agreed the group should continue its work.

	• The Commission agreed an F&A Committee recommendation for future recruitment policy to the Secretariat to be decided by the Bureau.
Financial contributions formula *Item 22* Report of the Finance & Administration Committee (IWC/64/Rep 2)	• The formula for calculating financial contributions (formerly known as the Interim Measure) which has been in place for several years was adopted, and the word 'interim' removed from its name.
Financial statements and budget *Item 24* Report of the Finance & Administration Committee (IWC/64/Rep 2)	• The Commission: (1) approved the Provisional Financial Statement for 2011/12 subject to audit; (2) adopted a budget for 2012/13 and 2013/14; and (3) agreed that for 2012/14 biennial period, the NGO fee be set at £550 for the first observer and £275 for additional observers and the media fee be set at £70. • The Commission agreed that the length of time served by the Commission's auditors should be included in the Secretariat's report to the Budgetary Sub-committee, and that the re-appointment of the auditor should become a specific agenda item. • The Commission agreed an F&A Committee recommendation for the Secretariat to review the procedures in the Financial Regulations in order to make it as straightforward as possible for countries with outstanding debts to repay those debts. • The Commission agreed an F&A Committee recommendation that the Commission should change its financial year to 1 January-31 December. The Secretariat was requested to develop a series of options to allow Contracting Governments to pay the amount owing for the four month 'bridging period'. • Donna Petrachenko (Australia) was re-elected as Chair of the F&A Committee.
Date and place of annual Meetings *Item 26*	• No date or place was proposed for the 2014 meeting. • The Government of the Republic of Korea kindly agreed to host the Scientific Committee meeting in 2013.
Elections and Bureau *Items 1 & 27*	• Jeannine Compton-Antoine (St Lucia) was elected as Chair of the Commission and Frederic Chemay (Belgium) was elected as Vice Chair. • The USA, Panama, Ghana, and Japan were elected to the Bureau. Thus the total membership of the Bureau will comprise the Chair (St Lucia), the Vice-Chair (Belgium), the Chair of the F&A Committee (Australia), and the four elected members. The Bureau will replace the Advisory Committee.

Chair's report of the 64th Annual Meeting

1. ELECTION OF CHAIR AND VICE-CHAIR

This item was originally scheduled to have been first on the order of business but was heard instead at the end of the meeting. The Commission elected, by consensus, Ms Jeannine Compton-Antoine (St Lucia) and Mr Frédéric Chemay (Belgium) as Commission Chair and Vice-Chair respectively.

2. INTRODUCTORY ITEMS

The 64th Annual Meeting of the International Whaling Commission (IWC) took place at the El Panama Conference Centre, Panama City, Panama from the 2-6 July 2012. Mr Bruno Mainini (Switzerland) acted as Chair for the meeting which was attended by 66 of the 89 Contracting Governments. Observers from 1 non-member government, 6 intergovernmental organisations, and 44 non-governmental organisations (NGOs) were also present. A list of the delegates and observers attending the meeting is given as Annex A. The associated meeting of the Scientific Committee was also held at the El Panama Conference Centre from 11-23 June 2012 and the Commission's other sub-groups met from 25-28 June 2012.

2.1 Welcome Address

The address was given by His Excellency Roberto Henriquez, the Foreign Minister of the Republic of Panama who welcomed delegates to Panama. He said that Panama's hosting of IWC/64 was a clear indication of its commitment to the international process of negotiation, and in particular its support to the different international organisations which work to conserve ecosystems.

He noted that Panama had recently shown both local and international commitment to the protection of cetaceans. A law passed in 2005 established Panama's marine corridor for the protection of marine mammals and also provided a frame work for the application of relevant policies including research, whalewatching, recreation, education, research, field therapy and also programmes for environmental awareness. Panama had declared marine mammals to be in need of conservation and preservation in order for them to re-establish and develop their populations. The law was strengthened by a number of regulations designed to ensure that it will be enforced.

The Minister reported that Panama was currently reviewing a draft order to create a national network for the rescue of stranded marine mammals. The draft national plan for stranded whales had been developed and was operated in conjunction with other institutions and tourism authorities so as to achieve the necessary international cooperation. Panama had also taken the initiative to educate their own citizens in conducting responsible and sustainable whalewatching in order to achieve the greatest possible benefit for all involved.

The minister invited the IWC to conduct this year's meeting with a positive and constructive spirit, especially given the challenging topics facing the IWC as it undergoes its process of change. He hoped that the meeting would mark a positive step forward so that the Commission could respond to the concerns of the international community. He stated that Panama would continue to work with the Commission and the other States that are involved in order to achieve agreement. In closing he encouraged everyone to enjoy their stay in Panama and to appreciate the many advantages that the country had to offer.

The response was given by Dr Simon Brockington, the Executive Secretary of the IWC. He referred to the difficulty of the issues faced by the IWC and recognised the organisation's strengths. In particular, he noted the commitment of the Contracting Parties and the increased amount of intersessional work which had taken place both prior to arrival in Panama and during the sub-committee week. He acknowledged the on-going progress with governance reform that had started with the consensus adoption of Resolution 2011-1 at IWC/63 and the present opportunity to move to biennial meetings. Finally, he referred to the considerable support provided to the Commission by the Scientific Committee, especially in relation to the Committee's ability to assemble and communicate knowledge on the state of whale stocks and the environment. In closing he thanked the Government of Panama for their comprehensive arrangements to host IWC/64, and wished all delegates and observers a successful meeting.

2.2 Opening Statements
Opening statements from Contracting Governments and Observers were received in writing and can be found on the IWC website[1].

2.3 Secretary's Report on Credentials, Voting Rights and Circular Communications
The Secretary reported that the Credentials Committee (comprising Japan, New Zealand and the Secretary) had met on the previous evening (1 July 2012). All credentials were in order except for those from the representative of the Government of Peru[2].

At the start of the meeting voting rights were suspended for Belize, Cameroon, Republic of Congo, Côte d'Ivoire, Dominica, Gambia, Greece, Guatemala, Republic of Guinea, Guinea Bissau, Hungary, Kenya, Mali, Mauritania, Nicaragua, Romania, Senegal, Slovak Republic and Suriname. The Secretary noted that if and when voting commenced he would call on San Marino (if present) to vote first.

A new Rule of Procedure (P.3) introduced in 2011 required all individual and circular communications from the Chair or Secretary to Contracting Governments to be placed on the Commission's public website. The Secretary reported that this had been achieved, and also confirmed that no confidential communications had been withheld from the website since the Commission's previous meeting.

2.4 Meeting Arrangements
The Chair referred to the importance of allowing all Contracting Governments to express their points of view, and hoped that this would be achieved without interruption. He also requested that calls for points of order be kept to a minimum.

The Chair confirmed the Commission's arrangements for speaking rights for representatives of non-member governments and other intergovernmental organisations, i.e. that they would be permitted to make one intervention on a substantive agenda item.

With regard to Non-Governmental Organisation (NGO) observers the Chair planned to allow interventions on five items, with a maximum of five minutes per item. He invited a maximum of ten representatives of the NGOs present to meet with him during the lunchtime recess on 2 July 2012 to identify the items in advance. Depending on the rate of progress during the week the Chair indicated that he would allow further interventions from NGO observers if time permitted.

2.5 Review of Documents
The Chair drew attention to document IWC/64/02 which was the list of documents to be considered at the 64th Annual Meeting. This list is provided at Annex C.

3. ADOPTION OF THE AGENDA

The Chair drew attention to the Annotated Provisional Agenda and to his proposed order of business.

Denmark noted that it had a dual capacity, both as a member of the European Union (EU) and simultaneously as a representative of Greenland and the Faroe Islands which are not members of the EU. Denmark stated that it generally aligns itself with the views and statements made on behalf of the EU, but that its comments at IWC/64 would be on behalf of Greenland and the Faroe Islands when there was a divergence of interest.

The Agenda was adopted by the meeting and is given as Annex B.

4. SANCTUARIES

4.1 South Atlantic Whale Sanctuary
4.1.1 Proposal for the establishment of a South Atlantic Whale Sanctuary
Brazil introduced a proposal to establish a South Atlantic Whale Sanctuary which was co-sponsored by Argentina, Brazil, South Africa and Uruguay. The same proposal had been submitted each year between 2001 and 2008, and also in 2011, with the decision on the 2011 proposal being deferred to the present meeting. The proposal was to add a new paragraph 7(c) to Chapter III of the Schedule of the International Convention for the Regulation of Whaling (1946), and was the same as the one submitted to IWC/63 in 2011 with the exception of modification to the wording regarding coastal waters under national jurisdiction:

[1] *www.iwcoffice.org/iwc64docs*
[2] Peru subsequently submitted its credentials later in the meeting.

> In accordance with Article V(1)(c) of the Convention, commercial whaling, whether by pelagic operations or from land stations, is prohibited in a region designated as the South Atlantic Whale Sanctuary. This Sanctuary comprises the waters of the South Atlantic Ocean enclosed by the following line: starting from the Equator, then generally south following the eastern coastline of South America to the coast of Tierra del Fuego and, starting from a point situated at Lat 55°07,3'S Long 066°25,0'W; thence to the point Lat 55°11,0'S Long 066°04,7'W; thence to the point Lat 55°22,9'S Long 065°43,6'W; thence due South to Parallel 56°22,8'S; thence to the point Lat 56°22,8'S Long 067°16,0'W; thence due South, along the Cape Horn Meridian, to 60°S, where it reaches the boundary of the Southern Ocean Sanctuary; thence due east following the boundaries of this Sanctuary to the point where it reaches the boundary of the Indian Ocean Sanctuary at 40°S; thence due north following the boundary of this Sanctuary until it reaches the coast of South Africa; thence it follows the coastline of Africa to the west and north until it reaches the Equator; thence due west to the coast of Brazil, closing the perimeter at the starting point. This prohibition shall be reviewed twenty years after its initial adoption and at succeeding ten-year intervals, and could be revised at such times by the Commission. Nothing in this sub-paragraph shall prejudice the current or future sovereign rights of coastal states according to, inter alia, the United Nations Convention on the Law of the Sea. With the exception of Brazil, this provision does not apply to waters under the national jurisdiction, according to its current delimitation or another that may be established in the future, of coastal states within the area described above, unless those States notify the Secretariat to the contrary and this information is transmitted to the Contracting Governments.

Brazil stated that the primary intention in creating the Sanctuary was to support the biodiversity, conservation and non-lethal use of whale resources in the South Atlantic Ocean. The Sanctuary was intended to maximise the rate of recovery of whale populations and to promote the long term conservation of whales with particular emphasis on breeding and calving areas and migratory pathways. The Sanctuary would also: (1) stimulate co-ordinated research programmes between developing countries and the IWC; (2) develop the sustainable and non-lethal utilisation of whales through ecotourism and whalewatching; (3) provide a framework for the development of measures at an ocean-basin level; and (4) integrate national and regional conservation and management strategies while taking into account the rights and responsibilities of coastal states. Brazil hoped that the proposal to amend the Schedule could be accepted by consensus.

4.1.2 Commission discussions and action arising

India, Colombia, Ecuador, Australia, Chile, Mexico, Cyprus (speaking on behalf of the European Union member states present at IWC/64) and Switzerland recorded their support for the proposal. India and Colombia re-iterated their commitment to conservation and non-lethal use of cetaceans, and Colombia noted the great economic advantages that whalewatching and ecotourism activities brought to vulnerable coastal communities. Ecuador stated that the Sanctuary would maintain the cetacean populations in the area and recalled that it had recognised its territorial waters as a whale sanctuary since 1990. Mexico said that there were six measurable objectives associated with the creation of the Sanctuary, the prime one being to allow the recovery rate of cetaceans to increase to its maximum capacity. Although there is no current commercial whaling, there had been previously and not all stocks had recovered to their historical levels.

Australia re-iterated its commitment to whale sanctuaries as an essential tool for the protection of whales and the broader marine environment. It stated that the creation of Sanctuaries was consistent with the ICRW and that their purpose was to benefit long term whale conservation by facilitating recovery through protection of feeding and breeding grounds as well as migratory routes. They also provided economic benefits by allowing the development of ecotourism and whalewatching, promoted international collaborative research, and increased public awareness and appreciation of the value and vulnerability of marine ecosystems. Australia said that its Prime Minister had recently re-affirmed the importance of area based conservation measures at the United Nations Conference on Sustainable Development. It stated that no commercial whaling or special permit whaling should be allowed in this proposed new Sanctuary or any other IWC Sanctuary, and it believed the Commission should adopt an integrated approach to conservation with the moratorium being complementary to, rather than an alternative to whale sanctuaries.

Japan, St Kitts and Nevis, Antigua and Barbuda, Norway and Iceland opposed the proposal. Japan said that the proposal did not contain specific or measurable objectives, and that it represented a shotgun approach to conservation whereby a large area would be protected with little rationale for boundary selection or establishment of management regimes. Japan and Antigua and Barbuda noted there was no support from the Scientific Committee for the proposal, and as such was contrary to the intention of Article V paragraph 2(b) of the ICRW 1946 which required amendments to the Schedule to be based on scientific findings. Japan noted that a moratorium on commercial whaling was already in place and therefore there was no requirement for additional measures, especially with the recovery of cetacean resources already underway.

St Kitts and Nevis said that the IWC represented just under half the countries in the international community and that the management of high seas living resources was the business of the entire international community and not just a relatively small number of states. St Kitts and Nevis, Antigua and Barbuda and Iceland questioned why the proposing countries had not included their own national waters as part of the Sanctuary, especially given the great implications of the Sanctuary on other maritime users, particularly fisheries and transport. Antigua and Barbuda re-iterated its earlier request for consultation with peoples in coastal states whose livelihoods may be affected by the establishment of the Sanctuary. St Kitts and Nevis noted that no other competent international organisations had supported the Sanctuary and expressed its concern that the proposal would ultimately lead to the closing off of the oceans from the rights and privileges of developing coastal states.

Norway supported the use of whale sanctuaries when they were scientifically justified. However it noted there was no scientific support for this proposal and as such it could not support it. Iceland's position was that no scientific or conservation advances could be gained by the establishment of the Sanctuary. Noting that there was no current whaling in the area, and that the conservation measures under the auspices of the IWC were possibly the most conservative of any international natural resource management organisation, Iceland considered that the proposed sanctuary could not provide any additional conservation benefits. It also noted that the proponents were predominantly from the western side of the South Atlantic, and that the proposal would have consequences for states on the eastern side, many of whom opposed the proposal.

In the absence of consensus the Chair asked the sponsors how they would like to proceed. In response, Brazil referred to the lengthy discussions that had taken place on its proposal, not just at IWC/63 in 2011 but also at many meetings since 2001, and accordingly asked for the proposal to be put to a vote. The result of the vote was that the proposal failed to achieve the required three-quarter majority support, there being 38 votes in support, 21 votes against and 2 abstentions.

Denmark explained its vote of support by recalling that on previous occasions it had announced its support for real sanctuaries which fulfilled a number of defining requirements. However, this year, Denmark had decided to vote yes. Despite this, Denmark stated that in future it would maintain its traditional conditions to new Sanctuaries, not least that they would require a positive recommendation from the Scientific Committee and that the support of coastal states would be of crucial importance. Denmark also stated that new proposals for Sanctuaries should contain provisions to regulate all human activities including for example fishing, sea transport and oil drilling.

Brazil expressed its disappointment at the result. It thanked those Contracting Governments who had supported the proposal and to the very transparent process by which the decision had been taken. Noting that all previous Sanctuaries established at IWC had been done so through a vote, it said that it saw the result not as an end point but instead as the starting point of a new process. Norway requested that if a proposal for a South Atlantic Sanctuary was to be tabled again, that it would be dealt with as a new proposal and given a full and thorough review by the Scientific Committee.

4.2 Other sanctuary issues raised in the Scientific and Conservation Committees

4.2.1 Report of the Scientific Committee

No new Sanctuary proposals had been received by the Scientific Committee.

4.2.2 Report of the Conservation Committee

The Chair of the Conservation Committee referred to the second International Conference on Marine Mammal Protected Areas which had been held in Martinique in November 2011 and which sought solutions to shared problems related to marine mammal conservation and to MMPA network design and management. A secondary goal was to orient those working in MMPAs to set protected areas in the broader context of marine management in order to ensure that MMPAs are not marginalised as marine spatial planning work advances. The conference theme was endangered species which included river dolphins and other species of large and small cetaceans as well as special attention to the endangered vaquita.

The USA highlighted the sister sanctuary agreement between the USA and France signed in September 2011 to protect humpback whales that migrate between the US Stellwagon Bank National Marine Sanctuary and the Agoa Marine Mammal Sanctuary in the Caribbean's French Antilles.

5. THE IWC IN THE FUTURE

5.1 Introduction

The Chair referred to the agreement made at IWC/63 in 2011 to: (1) encourage continuing dialogue amongst Contracting Governments regarding the future of the IWC; (2) to continue to build trust by encouraging Contracting Governments to coordinate proposals as widely as possible prior to their submission to the Commission; and (3) to encourage Contracting Governments to continue to cooperate in taking forward the work of the Commission, notwithstanding their different views regarding the conservation of whales and the management of whaling.

5.2 Commission discussions

Japan described the agreement made at IWC/63 in 2011 to continue dialogue to build mutual trust and collaboration as indispensable. It referred to the growing consensus being established around the proposal to move to biennial meetings as an example of effective procedures within the IWC.

New Zealand recalled that the Commission's membership had entered into discussions under this item united in the view that action was needed to resolve the deep divisions that prevented the IWC from taking meaningful action on many of the serious issues that had been before the Commission for many years. From New Zealand's perspective these issues were: (1) the special permit whaling carried out by Japan in the Southern Ocean and the North Pacific; (2) Commercial whaling under reservation by Iceland and objection by Norway in the North Atlantic; (3) the continued impasse on the establishment of the South Atlantic whale sanctuary; and (4) the willingness of a significant proportion of the membership to take part in and be guided by the discussions of the Conservation Committee. New Zealand noted these issues still divided the Commission and believed that it will need to come back to them again when the membership is willing to engage in the same spirit that characterised the discussions in 2007-2010.

The Russian Federation recalled the extensive progress made during the Future of the IWC process and asked whether the work would continue. It suggested the work of the Small Working Group established during 2007-2010 should continue so as to provide for the adoption of a package of measures which would include solutions to issues on global sanctuaries, strike limits for small type whaling and all the issues of the IWC Future. It requested discussion regarding this suggestion with the aim of establishing when the Small Working Group could re-assemble, and which issues it should be tasked with.

India said that it believed in conservation and that it did not support the exploitation of whales, and hence it was of the view that the moratorium should continue. It said that the IWC played an important role in the conservation of whales and that this must be carried out by all member countries. It should be achieved through the development of a comprehensive plan of action to recover depleted whale populations and address all threats to cetaceans including bycatch, ship strikes, ocean noise, pollution and the impact of climate change. Given these diverse roles, India suggested that the IWC be re-named the International Whales Commission.

The Republic of Guinea referred to the excellent work of the Scientific Committee and requested Commission members to accept the Committee's recommendations and to avoid antagonism. It stated that avoiding voting was important.

Australia considered that the Commission should engage in a ground up approach focusing on areas where agreement can be reached. It said that over the past few years the IWC had made significant progress on a range of financial and administrative governance reforms as well as conservation and science initiatives. Together these had helped to ensure there was a greater focus by the IWC on cetacean conservation whilst also improving the transparency and accountability of the Commission. Australia considered that through these reforms, the Commission could undertake work in line with the best practice and approaches of other international organisations and it acknowledged the important work undertaken by the Commission's Committees and intersessional groups. It believed that the IWC remained the appropriate international organisation to address the conservation management of whales and it believed that when consensus could not be achieved then a proper democratic vote should occur. Australia also stated that it considered the remit of the Small Working Group set up from 2007-2010 to be over, and that its work had been formally completed at previous meetings.

Mexico recalled that several previous processes to resolve the future of the Commission had all failed, and that before embarking on a new process it would be appropriate to analyse the reasons for past failure. As an alternative Mexico said that the Commission should seek a bottom up process and to look for issues where commonality existed (e.g. marine debris) and which would help the Commission work towards healthy whale populations and to maintain the functional elements of the ecosystem.

Argentina said that significant progress had been made over the last few years especially regarding the structure of the organisation. It considered that advances to find common ground had taken place in many areas including Sanctuaries, marine debris, climate change and other environmental matters. Argentina considered that the remit of the Small Working Group had ended at IWC/62 in 2010, but expressed its willingness to take part in all dialogue to modernise the Commission. Ecuador supported the comments by Australia and Argentina, and recognised the important efforts made by the IWC in matters related to whale conservation. Colombia noted the progress made with the conservation agenda, and said it was important to further strengthen the dialogue within the Commission so that all members were able to participate in the Commission's conservation mechanisms.

Korea referred to the existing divisions over whaling within the Commission and re-affirmed its commitment to the conservation and sustainable use of marine living resources. It considered that the stalemate within the Commission could only be broken by a commitment to the guiding principles embedded in the ICRW. It appreciated the co-operative spirit seen at IWC/63 in 2011 and expected that this same spirit would be applied to resolving the sensitive issues ahead during the present meeting.

Monaco believed that substantial teamwork was required to resolve the IWC's difficulties but there were also indicators of progress in the conservation and management of whales, as seen by the achievements made in the Conservation Committee. It remarked that the main problem facing the Commission was that its own Resolutions were ignored by some members, especially regarding the moratorium within the Southern Ocean Sanctuary. It commented that voting was a normal democratic process where consensus cannot be reached. Chile also recognised the IWC's achievements, and echoed the statements of Australia and Monaco that voting should be used when consensus could not be reached. Belgium highlighted three items that would assist the future development of the Commission, these being: (1) to strengthen the credibility and scientific capacity of the Commission with regard to both large and small cetaceans; (2) to improve the governance structure and to particularly pay attention to social issues; and (3) to further improve the IWC's collaboration with other organisations.

In closing the discussion, the Chair stated that consensus should always be the desired outcome but if that is not possible then voting should be used. He said that if voting was handled effectively, as it had been during the earlier discussion on the proposed South Atlantic Sanctuary[3] then it represented progress in comparison to the way it was previously conducted by the IWC.

6. WHALE STOCKS

6.1 Antarctic minke whales

6.1.1 Report of the Scientific Committee[4]

The Chair of the Scientific Committee referred to the Committee's ongoing work to conduct an in-depth assessment of Antarctic minke whales. In-depth assessments allow the Committee to determine the present status of stocks compared to their status in the past and to look at any trends in population level and possible causes of change. Ultimately, the assessments are intended to identify if there are anthropogenic threats to the population status that need to be addressed, as well as highlighting priority species, populations and/or human activities that require action.

For Antarctic minke whales, an ongoing issue was to develop a final set of abundance estimates from the international cruises undertaken under the auspices of the IWC (known as the IDCR and then SOWER cruises) obtained during the 1978/79–2003/04 austral summer seasons. Three sets of circumpolar (CP) cruises were undertaken and analytical efforts have focused on CPII (1985/86-1990/91) and CPIII (1992/93–2003/04). At IWC/62 in 2010, the Committee had established two sets of abundance estimates using two different analytical techniques. These estimates differed appreciably from each other, and following considerable extra work by the Committee in 2011 and 2012, the Chair of the Scientific Committee this year reported that the Committee has agreed final estimates for each of the survey areas. These can be seen in Table 1. The best estimates for the maximum extent of the Management Areas (hereafter 'Areas') that could be surveyed (for a number of logistical and environment-related reasons the extent of the Areas that could be successfully surveyed changed with time) are labelled 'survey once'. They are rounded to the nearest thousand animals. The uncertainty (CV) around the estimates for each is around 0.2 while the uncertainty around the total Antarctic estimates is around 0.1. These values increase if the additional variance associated with the different distribution of animals between surveys is taken into account; for the circumpolar estimates the CV becomes about 0.18.

In summary, the new agreed estimates for the survey-once case are 720,000 (95% CI 512,000; 1,012,000) for CPII and 515,000 (95% CI 361,000; 733,000) for CPIII (1992/93-2003/04). The estimates are to some degree underestimates because some minke whales would have been outside the northern and southern survey boundaries.

[3] Agenda Item 4.1.
[4] For a full account see JCRM 14 (suppl.), Item 10.1.

Table 1

Estimates of abundance for Antarctic minke whales for CPII (1985/86-1990/91) and CPIII (1992/93-2003/04). See text.

	Management Area						
CPII	I	II	III	IV	V	VI	Total
Survey once	86,000	130,000	93,000	55,000	300,000	56,000	720,000
CNB	85,000	120,000	87,000	51,000	286,000	50,000	678,000
CPIII	I	II	III	IV	V	VI	Total
Survey once	39,000	57,000	94,000	60,000	184,000	81,000	515,000
CNB	34,000	58,000	69,000	56,000	180,000	72,000	470,000
CPIII:CPII	0.40	0.49	0.79	1.09	0.63	1.44	0.69

Trends over time are of major interest in an in-depth assessment. The most appropriate estimates to examine are the consistent northern boundary (CNB in the table) estimates which have been corrected to make sure they are most comparable over time. These can also be seen in Table 1. The results also show that the biggest declines occurred in Areas I and II whereas the estimates in Areas IV showed no decline and in Area VI increased.

These corrected estimates over the entire Antarctic show a more recent total abundance estimate of around 30% lower than the earlier estimates. The confidence interval for the ratio between these two estimates includes 1.0 and thus a hypothesis of no change in the estimated overall abundance cannot be rejected. The Committee believes that the estimates probably represent a change and so is exploring possible causes for the decline in the estimates. The aim is to see if they represent a true decline in numbers rather than a result of e.g. changes in ice extent or distribution.

An in-depth assessment also needs information on stock structure to determine status and assess risks. For Antarctic minke whales, there are two genetically distinct populations in Area IV east and Area IV west. The Committee welcomed a new simple and effective method to determine the boundary between these two populations which appears to be a ‘soft’ boundary. This moves every year and appears to be sex-specific.

A population dynamics model containing all of this information will allow determination of the status, changes in abundance and carrying capacity. The model also requires information on catches and biological information on length, age, and sex. Initial results of these findings are expected next year.

Although the IDCR/SOWER series of cruises has finished the Japanese dedicated sightings surveys are still being conducted. With Committee approval with respect to methods, Japan was scheduled to conduct a dedicated sighting survey in Area III east, Area IV and Area V west. The Committee expressed regret that the actions of a protest group prevented the sighting survey in 2011/12. These surveys are the only dedicated cetacean sighting surveys in this region and so are very valuable to the work of the Committee.

It is planned to carry out the same survey in 2012/13. The primary objective is the estimation of abundance of Antarctic minke whales using agreed methods. In addition, opportunistic biopsy and photo-id studies of blue whales, southern right whales and humpback whales will be undertaken. A cruise report will be submitted next year. The Scientific Committee reviewed and endorsed these plans.

6.1.2 Commission discussions and action arising

Australia, Mexico, Japan and India thanked the Scientific Committee for their extensive work to resolve the population estimates of Antarctic minke whales. Australia said that the new estimates would be important complements to other Southern Ocean initiatives including the research projects being undertaken both through the Southern Ocean Research Partnership (SORP) and by the Commission for the Conservation for Antarctic Marine Living Resources (CCAMLR). Australia noted the decline between the two minke whale population estimates was not statistically significant, and that while a decline was most likely the data included the possibility that the population remained stable or even increased. This underlined the importance of continuing to work in a non-lethal way in the Southern Ocean to investigate whales and their environments.

Japan said the estimates were based in part on sightings surveys from designated areas with the exception of those areas were pack ice prevented access, and hoped that it would be possible to establish the reason for the different estimates between CPII and CPIII. Mexico also noted the possibility of the minke whale population decline, and asked whether the Scientific Committee had investigated ecosystem effects or climatic disruptions as underlying causes.

The Commission noted this part of the Scientific Committee’s report and endorsed its recommendations.

6.2 Southern Hemisphere humpback whales

6.2.1 Report of the Scientific Committee[5]

The Scientific Committee has been undertaking in-depth assessments of Southern Hemisphere humpback whales since 1992. Seven breeding stocks (labelled BS A-G) were recognised which were connected to feeding grounds in the Southern Ocean. Assessments for four of the breeding stocks had already been completed, these being:

BSA (eastern South America); BSC (eastern Africa); BSD (western Australia); and BSG (western south America).

In 2012, the Scientific Committee focussed on breeding stocks E (western South Pacific) and F (central South Pacific). These assessments took into consideration possible mixing of breeding stocks D and E on the feeding grounds.

At the start of the process the available data sets were assessed for these areas and a simple assessment model was used. The Committee had now agreed on a series of recommendations for the input data, whale movement models and population dynamics model structure to allow the assessment to progress. It planned to see results of these more realistic models during the year and then to finalise the in-depth assessment in 2014.

New data was reviewed on the other Southern Hemisphere breeding stocks that will eventually be used in future updated assessments and some of this information is from local countries.

An update had also been provided on the IWC's Antarctic humpback whale photo-identification catalogue that now has over 4,600 fluke photographs. New effort was focussing on obtaining photographs from eco-tourism cruise ships that sail in the Antarctic, in addition to those from scientific researchers. This catalogue has been and will continue to be extremely important in population assessments.

6.2.2 Commission discussions and action arising

India welcomed the information on the breeding stocks of Southern Hemisphere humpback whales and looked forward to the development of a conservation plan between the range state governments for the small populations of these whales along the western coast of Africa from Guinea to South Africa.

The Commission noted this part of the Scientific Committee's report and endorsed any recommendations.

6.3 Southern Hemisphere blue whales

6.3.1 Report of the Scientific Committee[6]

The Scientific Committee completed its circumpolar in-depth assessment of Antarctic blue whales in 2008. The assessment indicated that although this population is still severely depleted it appears to be increasing at around 8% annually. The Committee is now examining whether separate assessments can be carried out by population and Management Area. This will require information on abundance, distribution and stock structure by area and the Committee received additional relevant information this year.

Updates were received on the two Southern Hemisphere blue whale photo-identification catalogues including co-operative work. The photos of blue whales from the Japanese special permit programmes have been submitted to the Secretariat and these will be added to the Antarctic catalogue next year and compared to photos from other areas. A paper was received on pygmy blue whales of Western Australia, along with three papers on Chilean blue whales. Two papers contained abundance estimates but did not provide sufficient details for their acceptability for use in assessments to be determined. Guidelines will be clarified during the coming year with respect to the level of information that needs to be provided by scientists when they provide new abundance estimates.

The Committee also received six papers related to the Antarctic Blue Whale Project that is part of the Southern Ocean Research Partnership (SORP) project. The primary aim of the Antarctic Blue Whale Project is to estimate the circumpolar abundance of Antarctic blue whales using photographic mark-recapture methods. One paper summarised the results of two voyages already conducted. Four papers investigated various aspects of background research and the most effective way to carry out mark-recapture abundance methods. The last paper synthesised these ideas and presented a proposal for future cruises. Given the enormous area to cover and the required level of effort needed to obtain precise circumpolar abundance estimates, it may take up to 10 years to collect sufficient mark-recapture data, even when using passive acoustic techniques to help find blue whales to photograph. For this reason, the originally suggested 'Year of the Blue Whale' programme was agreed to be infeasible.

[5] For a full account see JCRM 14 (suppl.), Item 10.2.
[6] For a full account see JCRM 14 (suppl.), Item 10.3.

The Committee welcomed this work, recognised the importance of the research and agreed that a longer-term time line is more appropriate. In addition to this series of papers, the Committee also received a paper describing plans for the South African Blue Whale project which is to combine acoustic technology with traditional line transect sighting and mark-recapture surveys methods in waters off South Africa and in the Antarctic. Another paper was received on the genetics of Antarctic blue whales which requested use of some of the IWC genetic samples. The Committee provided some comments that might improve these plans and endorsed all of the proposed projects.

6.3.2 Commission discussions and action arising

Chile noted the importance of the blue whale as an emblematic species and noted that the population off the Chilean coast was very likely to be a different sub-species which it continued to study with the assistance of the Chilean Navy. Regarding the other populations of blue whales in the Southern Hemisphere, Chile highlighted its work to contribute to the international collaborative effort to compile the photo-identification catalogue in the expectation of being able to ascertain further information on the currently unknown breeding grounds and migratory routes which connect them to the known feeding areas. Chile also recorded its support for and contribution to blue whale work being undertaken through the Southern Ocean Research Programme.

The Commission noted this part of the Scientific Committee's report and endorsed any recommendations.

6.4 Western North Pacific gray whales

6.4.1 Report of the Scientific Committee[7]

One of the components of the draft western North Pacific gray whale conservation management plan (and see Item 9 below) agreed by IUCN and the IWC was a telemetry study to investigate the migration routes and breeding grounds. To accomplish this, an international and collaborative study was developed under the auspices of the IWC, beginning in 2010 and continuing in 2011. Several tags have been attached to gray whales off Sakhalin Island, Russia, a primary feeding ground as well as being the site of oil and gas activities. It was generally expected that animals feeding off Sakhalin Island migrated past Japan and Korea to breeding areas somewhere off China. In fact, the tagged animals travelled to the west coast of America. The animal with the longest lasting tag moved down the coast to Mexico and then returned to the Sakhalin Island feeding ground. The tagging results have identified the need for a major re-evaluation of the stock structure of gray whales in the North Pacific For example, as part of the IWC programme agreed last year, photo-id matches from these areas have confirmed that such movements from Sakhalin to the west are not isolated events; 14 whales photographed off Sakhalin Island have been matched to animals from Mexico (the total number feeding off Sakhalin Island is around 140 animals).

The Committee received a paper summarising past and current records of gray whales off the coasts of Japan, China and Korea. Recent records have been rare and the last known sighting off Korea was in 1977. The authors suggested that the portion of western gray whales that used to migrate past Korea might either have abandoned that route or may be extinct.

The new information suggests that the animals that feed off Sakhalin comprise animals from both the eastern and western populations and the Committee is giving priority to obtaining more information to understand stock structure in the North Pacific and to investigating any conservation implications.

There are plans for more tagging, in particular on gray whales off Kamchatka, Russia, off Barrow and Saint Lawrence Island, Alaska, and on PCFG (Pacific Coast Feeding Group) gray whales off of Oregon and California (see Item 7 below). Photographs and biopsies will also be collected. The tagged results will greatly assist the understanding of stock structure and also provide more local information, such as the distribution, movements and feeding areas as related to present and future oil and gas activities.

The Committee welcomed all of the information on this critically endangered population and the broader question of stock structure and commended the international collaboration thus far and recommended its continuation.

In terms of conservation advice, the Committee acknowledged the important work of the IUCN Western Gray Whale Advisory Panel and reiterated its support for the Panel. Further, the Committee recommended that appropriate monitoring and mitigation plans be implemented for all oil and gas activities that occur in the range of the western gray whales, especially around Sakhalin. The Committee again recognised that the problem of net entrapment of western gray whales is range-wide. In this context it welcomed Japan's actions to reduce mortality.

[7] For a full account see JCRM 14 (suppl.), Item 10.4.

6.4.2 Commission discussions and action arising

The Russian Federation noted that there was no agreement within the Scientific Committee regarding the existence of separate gray whale populations, and recalled the sightings of gray whales which occured in the North Atlantic off Spain and Israel two years ago, and off Franz Josef Land last year. This may even mean that gray whales were returning to the North Atlantic after 400 years of absence. Nonetheless, the Russian Federation recorded its support for protecting the western Pacific gray whales and their habitat. It noted the collaborative research work undertaken with the oil companies involved in the development around Sakhalin Island, and also reported that construction of the third oil and gas platform has passed the necessary Environmental Impact Assessment. The Russian Federation said it would continue to work collaboratively with NGOs as well as Oregon University and scientists from other organisations to study the gray whales and would report the results to the IWC's Scientific Committee. Monaco noted that the work on western North Pacific gray whales was an excellent illustration of international collaboration on what was considered a vulnerable population. It was concerned about the upcoming oil and gas developments off Sakhalin, and wished the the Russian Federation every success in applying the vital environmental assessments and ensuring that the developments were mitigated as much as possible.

Mexico highlighted the establishment of the first whale sanctuary in Baja California as one of the reasons for the recovery of the North Eastern Pacific gray whales, and suggested that following this example of recovery it would be appropriate to carry out a survey of the whole Pacific through the IWC to contribute to the Conservation Management Plan developed through the IUCN's Western Gray Whales Advisory Panel. Mexico thanked Japan for its efforts to reduce entanglement events, and recorded its concerns with plans to establish a third oil and gas exploration platform near the feeding areas for this population.

Korea said that it had designated this species as a natural monument in order to help achieve its protection and indicated that it would continue to undertake sightings surveys for this species even though it had not been seen in Korean waters since 1977. The United Kingdom supported the Scientific Committee's recommendations that appropriate monitoring and mitigation plans should be implemented for all oil and gas activities that occur throughout the range of western gray whales, especially if another platform was to be installed off Sakhalin Island. It welcomed all efforts to protect western gray whales and encouraged range states, energy companies and their lenders to engage with the IUCN's Western Gray Whale Advisory Panel. It requested that both the Panel and the IWC Scientific Committee should continue to look at ways to best protect the population.

The Commission noted this part of the Scientific Committee's report and endorsed its recommendations.

6.5 Southern Hemisphere right whales

6.5.1 Report of the Scientific Committee[8]

The Committee's work focussed on the report of a workshop[9] held in Buenos Aires, Argentina, in September 2011 that focused on the status of Southern Hemisphere right whales. The Committee endorsed the workshop's detailed recommendations and four of the more general ones are highlighted below.

(1) The annual long time-series of data collection projects should be continued. These projects provide important information such as calving intervals, abundance estimates, and provide photo-ids, genetic samples and tag data which can be used to define stock structure, animal movements and estimate rates of recovery.
(2) All countries should report incidents of ship strikes and entanglements in the annual progress reports submitted to the IWC.
(3) The joint Argentina/Brazil right whale assessment should be completed intersessionally, which will provide rates of increase for the time period 2000 to 2010.
(4) Draft Conservation Management Plans take into account the recommendations made during this workshop and the IWC Workshop on the Southern Right Whale Die-off that took place in 2010[10].

Once (3) is complete then the Committee can finalise its evaluation of status.

The Committee briefly examined the scientific content of the draft Conservation Management Plans for Southwest Atlantic southern right whales and for Southeast Pacific southern right whales and agreed that these draft plans did account for the recommendations suggested during the two workshops mentioned under (4) above. These plans were discussed more fully by the Conservation Committee (see Item 9 below).

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[8] For a full account see JCRM 14 (suppl.), Item 10.5.
[9] For a full account see JCRM 14 (suppl.), SC/64/Rep5.
[10] For a full account see JCRM 12 (suppl.), pp. 367-98.

6.5.2 Commission discussion and action arising

Argentina expressed its gratitude to the Scientific Committee for the work undertaken so far and looked forward to obtaining an estimate of the size of the Argentina/Brazil right whale population next year. It updated the Commission on a meeting which had taken place in May 2012 in the Province of Chubut to develop final solutions to the problem of gulls attacking right whales. Argentina also highlighted the health programme being undertaken in the waters around the Peninsula Valdez area that was investigating stranded and dead animals, especially those less than one year old, and said that it expected to be able to submit more findings from these studies to the IWC in the future.

Chile thanked Argentina for hosting the right whale assessment workshop, and drew attention to the right whale population off the coast of Chile and Peru that had been classified as critically endangered with fewer than 50 mature animals. It reported that it had introduced regulations which permitted whalewatching to take place only from the shore, rather than from boats, which was necessary because of the very small population size. It also highlighted the need to increase the records of sightings, photo-id and genetic studies in line with the recommendations of the assessment workshop so as to gain more information regarding the population.

The Commission noted this part of the Scientific Committee's report and endorsed its recommendations.

6.6 North Pacific and North Atlantic right whales and small stocks of bowhead whales

6.6.1 Report of the Scientific Committee[11]

The Committee has regularly expressed concern over these very small stocks and received a number of reports this year.

The North Atlantic Right Whale Consortium reported that according to their photo catalogue there were 490 North Atlantic right whales in 2010, 5 documented deaths and 11 new documented entanglements.

In the North Pacific, Japan reported that in February 2011, a right whale was found dead in a set net off Oita prefecture. A skin sample was sent to the Institute of Cetacean Research (ICR), where DNA was extracted and it was confirmed the animal was a right whale. Unfortunately, the sample was lost during the March 2011 tsunami. The Committee also welcomed the report of a western North Pacific right whale sighting survey conducted in May 2011 where a total of 20 individuals was detected, of which 19 were photographed and 14 biopsied.

With respect to bowhead whales, there was a year-round acoustic study during September 2008 to September 2009 off Spitzbergen, which is an old right whale whaling ground. The calls of the Spitzbergen stock of bowhead whales were recorded every day during November through February, with the highest calling rate during September through May.

The Committee thanked the authors for these reports and continued to reiterate its grave concern over these small stocks and encouraged continued or expanded research on these small populations.

6.6.2 Commission discussion and action arising

The Commission noted this part of the Scientific Committee's report and endorsed any recommendations.

6.7 North Pacific Research Cruises

6.7.1 Report of the Scientific Committee[12]

The primary focus was the international collaborative programme developed for the North Pacific under the auspices of the IWC which has been called IWC-POWER (Pacific Ocean Whale and Ecosystem Research).

The concept of a long-term programme was introduced two years ago. It was stressed that these cruises should be part of a well-designed medium-to-long-term programme, rather than a series of *ad hoc* cruises. The primary objective is to contribute information on abundance and trends in abundance of large whales and try to identify the causes of any trends that do occur. An important component of this programme in addition to the sightings surveys involves the use of photographs and biopsy samples from a variety of species. The short-term objective is to complete an initial 5-year survey of the eastern North Pacific to facilitate choice of appropriate survey blocks and strata for a long-term monitoring plan. It is also planned to undertake more specific power analyses of the effort required to detect trends in abundance, should trends occur. The results from these surveys are important because many of these populations have not been assessed for decades.

The 2nd annual IWC-POWER survey was successfully conducted from 11 July to 8 September 2011 in the eastern North Pacific (north of 40°N, south of the Alaskan Peninsula, between 170°W and 150°W) using a Japanese research vessel. The 3rd IWC-POWER survey will leave Japan on 13 July 2012 and will take place north of 40ºN to the US coast and between 140°W and 135°W. The Committee approved preliminary plans for a 4th cruise to occur in summer 2012 from 160º-135ºW, and between 30º- 40º; details will be finalised at a workshop to be held in Tokyo in October 2012.

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[11] For a full account see JCRM 14 (suppl.), Item 10.6.
[12] For a full account see JCRM 14 (suppl.), Item 10.8.

The Committee endorses the reports from all of these surveys and looked forward to receiving more detailed reports and results. It was extremely grateful to Japan for providing a vessel for these cruises, recognising that providing a dedicated vessel is a major donation to the Committee's work. Data from the first three years of the IWC-POWER cruises will be invaluable in the forthcoming in-depth assessment of sei whales. The Committee encouraged other range states to contribute to and collaborate with the IWC-POWER programme and thanked the USA and the Republic of Korea for their assistance with the cruises undertaken so far and the future planned surveys.

In addition to these IWC-directed surveys, the Committee was informed that three systematic dedicated cetacean sighting surveys were conducted by Japan in summer 2011 and that a similar set is planned for summer 2012. The objectives are to examine the distribution and abundance of large whales in the Western North Pacific following IWC requirements and guidelines. Biopsy sampling and photo-identification data will also be collected on an opportunistic basis.

6.7.2 Commission discussion and action arising

Japan stated the importance of undertaking the research cruises and promised to co-operate in future surveys. It highlighted the tentative estimate of 6,587 sei whales for the eastern North Pacific[13] that had been obtained from the 2011 IWC-POWER cruise and noted that a similar survey would take place in the summer of 2012. It acknowledged the support of the USA in allowing the survey vessel to enter American waters and the support provided by Korea and the IWC Secretariat.

The Commission noted this part of the Scientific Committee's report and endorsed any recommendations.

7. ABORIGINAL SUBSISTENCE WHALING

The Aboriginal Subsistence Whaling Sub-committee met on the 27 June 2012 under the Chairmanship of Herman Oosthuizen (South Africa). It was attended by delegates from 29 Contracting Governments. The Chair of the Scientific Committee's Standing Working Group (SWG) on the Development of an Aboriginal Whaling Management Procedure reported on the Scientific Committee's work and discussions. The full report of the ASW Sub-committee is available at Annex E.

7.1 Aboriginal Subsistence Whaling Management Procedure

7.1.1 Report of the Aboriginal Subsistence Whaling Sub-committee

7.1.1.1 CONTINUATION OF WORK ON DEVELOPING *SLAS* FOR THE GREENLANDIC HUNTS

The Scientific Committee had developed and the Commission endorsed an interim safe approach to setting catch limits for the Greenland hunts in 2008, noting that this should be considered valid for up to two quota blocks. The target is for the Committee to have developed agreed and validated strike limit algorithms (*SLA*s) by species by the 2018 Commission Meeting. The interim safe approach uses an *SLA* that has been simulation tested in the normal manner but not for as full a range of scenarios as a formal long-term *SLA*.

For a number of reasons, primarily related to stock structure issues, development of *SLA*s for Greenland aboriginal hunts for common minke and fin whales will be more complex than previous *Implementations* for stocks subject to aboriginal subsistence whaling. While noting Greenland's desire for flexibility amongst species in meeting its subsistence needs, the Scientific Committee will first develop *SLA*s for individual species before considering whether and how to address multispecies considerations.

The Scientific Committee received a brief report from Greenland related to the recommendations in IWC/62/9 to develop conversion factors from tonnes of edible products to numbers of whales by species. The Committee made recommendations for improved reporting next year.

A paper (IWC/64/ASW10) was presented by Greenland to the Commission's Aboriginal Subsistence Whaling Sub-committee. Its current need statement and request (see Item 7.5.2) used the conversion factors per animal included in IWC/62/9. In discussion, several countries thanked Denmark/Greenland for presenting this more detailed updated progress report. Others reiterated the Scientific Committee's concerns and looked forward to the full progress report that Denmark/Greenland will be submitting next year.

The Aboriginal Subsistence Whaling Sub-Committee endorsed the report of the Scientific Committee and its recommendations.

[13] JCRM 14(suppl,), Item 10.9.

7.1.1.2 IMPLEMENTATION REVIEW OF EASTERN NORTH PACIFIC GRAY WHALES WITH EMPHASIS ON PCFG
At the 2010 Annual meeting it was agreed that the information on stock structure and proposed hunting by the Makah Tribe warranted the development of trials as part of an immediate new *Implementation Review* with a primary focus on the PCFG (Pacific Coast Feeding Group) that was in essence to be treated as a separate management stock from the large eastern North Pacific population from which the Chukotkan hunt was taken. After work by the Committee at two annual meetings and two intersessional workshops, the Committee completed this task this year.

Based on the Commission's objectives for aboriginal subsistence whaling, the Scientific Committee explored the conservation performance of 11 variants of a management plan proposed by the Makah Tribe to reduce the likelihood that a PCFG whale might be taken in the hunt. The Committee concluded that

(1) SLA variant 2 performed acceptably and met the Commission's conservation objectives;

(2) SLA variant 1 performed acceptably provided that it is accompanied by a photo-identification programme to monitor the relative probability of harvesting PCFG whales in the Makah U&A, and the results presented to the Scientific Committee for evaluation each year.

However, the Scientific Committee noted that the SLA variants tested did not correspond exactly to the management plan proposed by the Makah to the IWC. It agreed to test such a variant intersessionally and examine the results at the next Annual Meeting.

In addition, last year[14] the Scientific Committee had stressed that new information on movements of gray whales highlighted the importance of further clarification of the stock structure of North Pacific gray whales. In particular, the matches of animals from the Sakhalin feeding grounds with animals seen in the PCFG area and other areas along the west coast emphasised the need for efforts to estimate the probability of a western gray whale being taken in aboriginal hunts for Pacific gray whales (noting that this did not require incorporation of western gray whales into the *Implementation Review*). It again strongly endorsed the collaborative stock structure research programme (see Item 6.4 above), noting that the results of the research may require further trials for future *SLA* testing; this would be a matter for consideration at the next *Implementation Review,* if not before.

The Scientific Committee will continue to monitor the situation and was willing to respond to any guidance or requests for further information from the Commission.

The Aboriginal Subsistence Whaling Sub-Committee endorsed the report of the Scientific Committee and its recommendations.

7.1.2 Commission discussions and action arising
There were no discussions under this item.

7.2 Aboriginal Whaling Scheme
7.2.1 Report of the Aboriginal Subsistence Whaling Sub-committee
An integral part of the AWMP process within the Scientific Committee is the undertaking of regular or 'special' *Implementation Reviews*. The Scientific Committee developed and adopted guidelines for these this year which cover the following issues: (1) Objectives; (2) Timing of regular and special *Implementation Reviews*; (3) Outcomes; (4) Data Availability; (5) Computer programmes.

In 2002, the Scientific Committee had recommended that the Commission adopt the Aboriginal Subsistence Whaling Scheme. This covered a number of practical issues such as survey intervals, carryover and guidelines for surveys. The Committee has stated in the past that the AWS provisions constitute an important and necessary component of safe management under AWMP *SLAs* and it reaffirmed this view this year, noting that discussions within the Commission of some aspects such as the 'grace period' are not yet complete.

The Commission's Aboriginal Subsistence Whaling Sub-Committee noted the report of the Scientific Committee.

7.2.2 Commission discussions and action arising
There were no discussions under this item.

7.3 Aboriginal Subsistence Whaling Working Group (ASWWG)
In 2011, the Commission endorsed a recommendation in document IWC/63/12rev to form an Ad Hoc Aboriginal Subsistence Whaling Working Group (ASWWG). The purpose of the group was to identify and consider unresolved ASW issues, including *inter alia* those identified in the 2011 report of the ASW Sub-committee.

[14] JCRM 13(suppl.) p.16.

7.3.1 Report of the Aboriginal Subsistence Whaling Sub-committee

The ASWWG reported a series of five short term recommendations and these were subsequently endorsed by the ASW sub-committee (while noting the reservations of one member of the ASWWG). One of the recommendations was to propose the creation of a voluntary fund at IWC/65, and this was referred to the Finance and Administration Committee. See Item 25.3.3 for report of F&A discussions.

7.4 Aboriginal subsistence whaling catch limits

7.4.1 Report of the ASW Sub-committee

SETTING OF CATCH LIMITS FOR AN EVEN NUMBER OF YEARS

At IWC/64 the Commission considered a change from annual to biennial meetings. This raised the issue as to whether there were any scientific implications for the Commission moving to setting block quotas for an even number of years rather than the present five-year intervals. This was examined by the Scientific Committee. It agreed that there are no scientific reasons for the Commission not to set catch limits for blocks of even numbers of years up to 8-years for BCB bowhead and eastern gray whale stocks. Given the interim safe approach, the Committee also agreed that there are no scientific reasons why the next quota block for the Greenland hunts could not be for a 6-year period, noting that the long-term *SLA*s will be available for implementation for the following block quota.

7.4.1.1 BERING-CHUKCHI-BEAUFORT SEAS STOCK OF BOWHEAD WHALES (ANNUAL REVIEW)

A total of 51 bowhead whales were struck in 2011 resulting in 38 animals landed. No bowhead whales were reported struck and lost at Chukotka. The Scientific Committee agreed that the *Bowhead SLA* continued to be the most appropriate way for the Committee to provide management advice for the BCB population of bowhead whales and that the present strike and catch limits are acceptable.

The need statement for BCB bowhead whales by the USA is given as IWC/64/ASW3 (summarised in IWC/64/Rep3, Annex D) and for the Chukotkan hunt is given in IWC/64/ASW6 (summarised in IWC/64/Rep3, Annex E).

The Aboriginal Subsistence Whaling Sub-Committee endorsed the report of the Scientific Committee and its recommendations. It also accepted the need statements provided by the USA and the Russian Federation.

COMMISSION DISCUSSIONS AND ACTION ARISING

There were no discussions relating to the Annual Review. Discussions regarding future catch limits are reported at Section 7.5.1.

7.4.1.2 NORTH PACIFIC EASTERN STOCK OF GRAY WHALES[15]

The Russian Federation reported that a total of 128 gray whales were struck in Chukotka, Russia in 2011; two were lost and 126 were landed. Of the landed whales, two were stinky and not used for human consumption. In addition to the *Implementation Review* with the focus on PCFG gray whales, the Committee reviewed a wide range of excellent papers on this stock including papers from Mexico, the USA and the Russian Federation. A number of research recommendations were made but no information was presented that warranted any re-evaluation of the gray whale *SLA*.

The Scientific Committee therefore agreed that the *Gray Whale SLA* remains the appropriate tool to provide management advice for eastern North Pacific gray whales apart from the consideration of the PCFG and the Makah hunt (for which see the discussion above under Item 7.1.1.2). It reiterated that the current strike limits will not harm the stock.

The need statement for the eastern gray whale hunt off Chukotka was document IWC/64/ASW6 (summarised in IWC/64/Rep3, Annex E) while the need statement for Makah hunt was IWC/64/ASW4 (summarised in IWC/64/Rep3, Annex E).

The Aboriginal Subsistence Whaling Sub-committee endorsed the report of the Scientific Committee and its recommendations. It also accepted the need statements provided by the USA and the Russian Federation.

COMMISSION DISCUSSIONS AND ACTION ARISING

Austria asked the USA to clarify the domestic situation, and especially the pending law suits regarding the Makah hunt. The USA responded that the Makah Tribe of Washington State must satisfy domestic legal requirements as a pre-requisite to conducting an ASW hunt, and that the process to satisfy these requirements was underway. The USA also reported that its National Oceanic and Atmospheric Administration had recently indicated its intention to prepare a new environmental impact statement for the proposed Makah hunt of gray whales. The USA confirmed that, as in 2007, its current proposal to update catch limits was subject to domestic legal requirements including the evaluation of the environmental impact assessment.

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[15] See also Item 7.1.1.2 on the *Implementation Review* for gray whales.

Discussions regarding future catch limits are reported at Section 7.5.1.

7.4.1.3 COMMON MINKE WHALE STOCKS OFF GREENLAND

REPORT OF THE ABORIGINAL SUBSISTENCE WHALING SUB-COMMITTEE

The Committee re-emphasised the importance of collecting genetic samples from these whales, particularly in the light of a proposed joint AWMP/RMP workshop. The Scientific Committee's management advice covered two hunts: that off West Greenland and that off East Greenland.

In the 2011 season 174 minke whales were landed in West Greenland and 6 were struck and lost. Of the landed whales, there were 133 females, 39 males, and two whales of unreported sex. Genetic samples were obtained from 90 of these whales. Based on a negatively biased estimate of abundance of 17,307 (95% CI 7,628-39,270) and application of the agreed interim approach, the Committee repeated its advice of last year that an annual strike limit of 178 will not harm the stock.

For East Greenland, in the 2011 season, 9 common minke whales (all females) were landed and one was struck and lost. The Committee noted that the strike limit of 12 represented a very small proportion of the Central Stock of common minke whales which numbers around 40,000 animals. The Committee repeated its advice of last year that the present strike limit will not harm the stock.

The Aboriginal Subsistence Whaling Sub-committee endorsed the report of the Scientific Committee and its recommendations.

Given the multi-species nature of the Greenland hunts, the Aboriginal Subsistence Whaling Sub-committee agreed that the question of need should be considered for all hunts simultaneously.

COMMISSION DISCUSSIONS AND ACTION ARISING

There were no discussions under this item. Consideration of future catch limits can be found at Item 7.5.2.

7.4.1.4 WEST GREENLAND STOCK OF FIN WHALES

REPORT OF THE ABORIGINAL SUBSISTENCE WHALING SUB-COMMITTEE

A total of five fin whales (all females) were landed in West Greenland during 2011 and none were struck and lost,. No genetic samples were obtained in 2011 and the Committee re-emphasised the importance of collecting genetic samples from these whales in the light of the proposed work to develop a long-term *SLA* for this stock. Based on the agreed 2007 estimate of abundance for fin whales (4,539 95% CI 1,897-10,114), and using the agreed interim approach, the Scientific Committee repeated its advice that an annual strike limit of 19 whales will not harm the stock.

The Aboriginal Subsistence Whaling Sub-committee endorsed the report of the Scientific Committee and its recommendations.

Given the multi-species nature of the Greenland hunts, the Aboriginal Subsistence Whaling Sub-committee agreed that the question of need should be considered for all hunts simultaneously.

COMMISSION DISCUSSIONS AND ACTION ARISING

There were no discussions under this item. Consideration of future catch limits can be found at Item 7.5.2.

7.4.1.5 WEST GREENLAND STOCK OF BOWHEAD WHALES

REPORT OF THE ABORIGINAL SUBSISTENCE WHALING SUB-COMMITTEE

Discussion within the Scientific Committee in recent years has focussed on stock structure and associated abundance estimates. The present working hypothesis is that bowhead whales in eastern Canada-West Greenland comprise a single stock; the alternative hypothesis assumes two stocks: one in Hudson Bay-Foxe Basin and another in Baffin Bay-Davis Strait. The Committee welcomed a number of papers related to this stock.

In 2011, one female bowhead whale was landed in West Greenland and none were struck and lost. Two bowhead whales were found dead in West Greenland in 2011, entangled in fishing gear for crabs. During 2011, three bowhead whales were taken in Canada. More detailed information (e.g. sex, size) was made available by Canada to the Secretariat. The Scientific Committee was pleased to receive this information including catch as well as struck/lost data. It requested that in the future Canada also provided information on any strandings, entanglements and ship strikes of bowhead whales.

The agreed abundance estimate for eastern Canada-West Greenland is 6,344 (95% CI: 3,119-12,906) for 2002. The most recent agreed estimate for the spring aggregation in the West Greenland area is 1,747 (95% CI: 966-2,528) for 2010. Using the agreed interim approach, the Scientific Committee repeated its advice that an annual strike limit of 2 bowhead whales will not harm the stock. Should Canadian catches continue at a similar level as in recent years, this would not change the Committee's advice with respect to the strike limits agreed for West Greenland.

The Aboriginal Subsistence Whaling Sub-committee endorsed the report of the Scientific Committee and its recommendations.

Given the multi-species nature of the Greenland hunts, the Aboriginal Subsistence Whaling Sub-committee agreed that the question of need should be considered for all hunts simultaneously.

COMMISSION DISCUSSIONS AND ACTION ARISING

There were no discussions under this item. Consideration of future catch limits can be found at Item 7.5.2.

7.4.1.6 HUMPBACK WHALES OFF WEST GREENLAND

REPORT OF THE ABORIGINAL SUBSISTENCE WHALING SUB-COMMITTEE

A total of eight humpback whales comprising three males and five females were landed in West Greenland during 2011 and none were struck and lost. Genetic samples were obtained from three of these whales. The Scientific Committee re-emphasised the importance of collecting genetic samples and photographs of the flukes from these whales, particularly with respect to the YoNAH and MoNAH initiatives.

The agreed estimate of abundance for humpback whales off West Greenland is 3,039 (CV 0.4) with an annual rate of increase of about 9%. Using the agreed interim approach, the Scientific Committee repeated its advice that an annual strike limit of 10 whales will not harm the stock.

The Aboriginal Subsistence Whaling Sub-committee endorsed the report of the Scientific Committee and its recommendations.

Given the multi-species nature of the Greenland hunts, the Aboriginal Subsistence Whaling Sub-committee agreed that the question of need should be considered for all hunts simultaneously.

COMMISSION DISCUSSIONS AND ACTION ARISING

There were no discussions under this item. Consideration of future catch limits can be found at Item 7.5.2.

7.4.1.7 CONSIDERATION OF NEED AND CATCH LIMITS FOR THE GREENLANDIC HUNTS

REPORT OF THE ABORIGINAL SUBSISTENCE WHALING SUB-COMMITTEE

The need statement for the Greenlandic hunts was given as IWC/64/ASW7 and 8 and summarised in IWC/64/Rep3, Annex G. Denmark/Greenland noted that its request was consistent with Scientific Committee management advice and thus provided no threats to any of the stocks. It stated that its proposed catch limits for bowhead whales and for common minke whales off West and East Greenland were unchanged, although modified for a six-year period. The proposed annual catch for humpback whales was for 10 animals, an increase of one from the current quota while that for fin whales is for 19 an increase of 3 from the current quota. They stated that their request was consistent with the multispecies need of 670 tonnes of edible products for west Greenland and 12 common minke whales for East Greenland.

There was considerable discussion regarding the need statement by Greenland and there was no consensus over this issue within the Sub-Committee. Topics discussed included conversion factors, availability of whale meat in restaurants, political practicalities and human health. The Chair of the Sub-committee had urged all countries to use the time between the close of the meeting and the Plenary to engage in further discussions in order to improve mutual understanding of positions and to try to reach consensus.

COMMISSION DISCUSSIONS AND ACTION ARISING

There were no discussions relating to the report of the ASW Sub-committee. Discussions regarding future catch limits are reported at Item 7.5.2

7.4.1.8 NORTH ATLANTIC HUMPBACK WHALES OFF ST VINCENT AND THE GRENADINES

REPORT OF THE ABORIGINAL SUBSISTENCE WHALING SUB-COMMITTEE

The Scientific Committee made recommendations for the collection of future genetic and photo-id data. It has agreed that the animals found off St. Vincent and The Grenadines are part of the large West Indies breeding stock (numbering around 11,600 animals in 2003) and it repeated its advice of last year that this block catch limit will not harm the stock.

The need statement for the Bequian hunt was given as IWC/64/ASW11 (summarised in IWC/64/Rep3, Annex H). St Vincent and The Grenadines had been unable to attend the meeting last year and provided additional information on several aspects of the hunt. The strike/catch limit requests from St Vincent and The Grenadines is at the same level as before, although scaled to a six-year block.

A number of comments were made on the provision of data and the need statement. One country stated that it believed that the proposed quota was excessive.

The Aboriginal Subsistence Whaling Sub-committee endorsed the report of the Scientific Committee and its recommendations.

COMMISSION DISCUSSIONS AND ACTION ARISING

St Vincent and The Grenadines confirmed that samples were collected from one humpback whale in 2001 and two humpback whales in 2002 and sent to Japan for genetic analysis. Samples were also sent to Dr Palsbol who compared the genetic data of the St Vincent and The Grenadines samples with the information on North Atlantic humpback whales held in his own database. The results indicated that there was no DNA match between the St Vincent and The Grenadines samples and those already held on the database. Samples were also collected in 2003, 2004 and 2006 but were not sent for analysis because of problems encountered with processing of CITES permits which affected the preservation of the samples, and hence those samples were discarded without analysis. St Vincent and The Grenadines confirmed that following discussions with the USA they had rectified this problem and that samples from this year's humpback take were now with a laboratory in the USA. Photographs were also sent to the North Atlantic Humpback Whale Catalogue in 2003, 2004 and 2006 and to the Secretariat in 2012.

Argentina requested a further clarification of the number of individuals caught or struck and lost through the St Vincent and The Grenadines hunt. Specifically, Argentina noted the report of one individual caught on 14 April 2012, and the reference in IWC/64/Rep3 of another individual caught on 11 April 2012 and asked if these were the same whale. Argentina also noted reference to a struck and lost individual on 22 March 2012 in IWC/64/Rep3. St Vincent and The Grenadines responded that at Annual Meetings they reported catch and strike information for the previous season, however its absence from the 2011 meeting necessitated the transmission of information for the 2012 and 2011 seasons to the Secretariat. It also confirmed that it had reported on one whale taken in 2012 which was verified, photographed and sampled. Given the 2012 season was nearly over St Vincent and The Grenadines would be interviewing crews to verify the number of struck and lost animals and would report findings next year to the Commission.

The UK welcomed the submission of biological samples, photographs and other data from the hunts that had been requested by the Scientific Committee, as well as the information needed by the Commission and working groups. It encouraged timely provision of such information in the future, and requested a commitment to supply data to and participate fully in the Whale Killing Methods Working Group and workshops to improving the welfare of hunted whales, a transition to more humane weapons, reduced times to death and reduced struck and lost rates.

7.4.1.9 STATEMENT FROM THE ASW COUNTRIES

The Chair of the ASW Working Group reported that the working group had received a statement made on behalf of the ASW countries which agreed that ASW hunts are important for food security and reaffirmed the four major points affecting each aboriginal hunt (agreed at IWC/58) which were that: (1) subsistence hunting is for food to meet cultural and nutritional needs; (2) the safety of his crew is a whaling captain's most important responsibility; (3) with safety assured, achieving a humane death for the whale is the highest priority; and (4) efforts to modernise whaling equipment and practices can only be made within the context of each communities' economic resources and the need to preserve the continuity of hunting traditions.

7.4.1.10 COMMISSION DISCUSSION AND ACTION ARISING

Australia reiterated its previous concern over the continued use of ad-hoc advice for populations for which adequate scientific information was not yet available for full *SLA* calculations. It noted that this year the Scientific Committee did not give advice on the possible extension of the duration of the quota for St. Vincent and The Grenadines, and said that it would not ordinarily wish to see the duration of this quota extended but also recognised the extenuating circumstances arising from a possible move to biennial meetings. It emphasised that further strike limits should not be set beyond the usual period unless it was done using formal and agreed *SLAs* under the Aboriginal Whaling Management Procedure. Korea requested a justification for the possible extension of the catch limit period from five years to six years, and suggested that a four year block quota period should also be considered, and Argentina suggested that it may not be advisable to move away from the five year block quota period. Chile also requested clarification on the proposed move to biennial meetings so as to support the decision making process on length of ASW catch limits.

Argentina referred to the discussions within the ASW Working Group on the standardisation of catch limits in terms of number of whales or tons of whale meat and expressed its view that catch reports should be expressed in terms of numbers of whales because the discarding of meat, blubber and internal organs introduced certain difficulties. Denmark responded that the West Greenland hunt was a multi-species hunt and that the human needs were 670 tons of whale meat, as it had been for many previous years, and that this figure could be satisfied by various combinations of the species.

Argentina expressed concern in relation to the Greenland catches where it considered there was a commercial component which was higher than would be allowed under the ASW definition, and in relation to the St Vincent and The Grenadines catches where it agreed with the statements of the Dominican Republic that there were no longer any indigenous Caribbean peoples and that there was a confusion between a family tradition and a cultural tradition. Mexico and Brazil supported Argentina's remarks and Brazil suggested that these two hunts be examined individually and on their own merit. Denmark responded that the Greenland hunt fulfilled all criteria for aboriginal subsistence whaling as described in document IWC/64/ASW7. St Vincent and The Grenadines responded that they had been in receipt of an aboriginal subsistence whaling quota for 25 years and that the aboriginal nature of the hunt had been accepted in the previous periods. Monaco, supported by Mexico, recognised that the hunt had been granted for 25 years, but said that the aboriginal nature of the hunt had never been convincingly demonstrated during this period. It also said that a tradition which could only be traced back to 1875 does not qualify as aboriginal, and that the St Vincent and The Grenadines hunt was an anomaly within the overall structure and regime of ASW.

India's view was that the IWC should work to reduce the aboriginal dependence upon whales in a phased manner, and that this should be achieved by identifying those aboriginals dependent on whaling and by seeking to establish alternate socio-economic conditions including whalewatching and eco-tourism. India also stated its appreciation for the work of the Scientific Committee in advising on the proposed catch limits. The Russian Federation asked if India had taken account of the geography, harsh climate and high latitude where the Inuit communities were living and remarked that it is obvious there are no resources other than those provided by nature and the wildlife, and also that the aboriginal people are relying in their diet upon marine mammals. The Russian Federation recalled that over the last 12 months it had joined a diplomatic conversation with the Indian Government and had received a statement that the Government of India would further research the situation. It hoped this bilateral conversation would continue. St Vincent and The Grenadines found the statement by India regrettable since the IWC had established parameters on aboriginal subsistence whaling over many years in recognition of the needs of people who required to take whales for their existence and survival. India clarified that it was not opposed to subsistence whaling where based upon an assessment of dietary and cultural requirements, but that it was opposed to commercial subsistence whaling. It re-stated that subsistence whaling may be phased out over a period of time depending on the changing structure of economic conditions through alternate livelihood opportunities.

Guinea commended the recommendations of the Scientific Committee and noted that the controlled use would not harm the identified stocks. Belgium stated that the Scientific Committee's report and recommendations provided the starting point for the ASW discussion, rather than the end point. It noted that many socio-economic implications must be taken into account when deciding whether to agree quota extensions or not.

The Commission noted the report of the ASW Sub-committee and endorsed its recommendations.

7.5 Proposals for Aboriginal Subsistence Whaling catch limits

7.5.1 Proposed catch limits for bowhead, gray and humpback whales

The USA introduced document IWC/64/10 which was a proposed Schedule amendment submitted on behalf of the Russian Federation, St Vincent and The Grenadines and the USA to set ASW quota for these countries for the six year period 2013-2018 at the same annual level as had taken place in the preceding five year period 2008-2012. The USA explained that the six year (rather than five year) period was appropriate in order to fit in with the Commission's expected move to a biennial meeting cycle, and recalled the Scientific Committee's advice that block periods of up to eight years in length meet the conservation objectives established by the IWC. Regarding the management regime for the St Vincent and The Grenadines hunt, the USA recalled the Scientific Committee's advice that the proposed catch limit using a five year block quota would not harm the stock, and the subsequent advice from the Head of Science that the performance results of a six year block would be indistinguishable from a five year block. On the question of effects of carry over, the USA highlighted the simulations undertaken by the Scientific Committee which had shown that the current carry over provisions of quota to subsequent years for gray whales and bowhead whales were well within levels consistent with the conservation objectives established by the Commission. Finally, on the question of the aboriginal nature of the St Vincent and The Grenadines hunt, the USA recalled that the Commission uses definitions of subsistence use, and at past meetings the Commission had agreed that the harvest as practiced at St Vincent and The Grenadines is consistent with these definitions.

The Chairman of the Alaskan Eskimo Whaling Commission, George Noongwook, spoke on behalf of the Alaskan villages which depended on bowhead whales. He explained that in these villages there were few sources of employment and limited supplies of food. Consequently, most of the food was taken from the ocean in the form of whales, walrus, seals and fish. He went on to explain the seriousness with which the villages took the IWC decisions as it deeply affected their way of life. He highlighted the scientific conclusions which confirmed the bowhead stock is healthy and able to support the hunt. He also recalled the long term increase in the average efficiency of the hunt despite the deteriorating ice conditions.

COMMISSION DISCUSSIONS AND ACTION ARISING

Japan thanked the USA for its explanation and recalled its view that it is important to promote the sustainable use of marine resources based upon scientific findings. Accordingly, it strongly supported the joint proposal contained in IWC/64/10. Guinea re-iterated the Scientific Committee's advice that the proposed use would not harm the stocks and indicated its support for the package proposal.

St Lucia, supported by Grenada and Tanzania, noted that there was no United Nations definition of what constitutes aboriginal but also clarified that there are full blooded indigenous peoples living in the eastern Caribbean states. It re-iterated the Scientific Committee's advice that the proposed hunts would not harm the stocks and in relation to the issue of food security noted that the proposed hunts were to provide food for aboriginal peoples. St Lucia considered that a take of 4 animals from a total of 11,000 whales through the aboriginal hunt in St Vincent and The Grenadines would not affect the whalewatching industry in other parts of the Caribbean. In regards to commerciality, St Lucia recognised the costs incurred in reducing times to death and indicated that being able to sell at least a small portion of the quota would be necessary to recover the costs.

St Kitts and Nevis, supported by Grenada and Tanzania, congratulated the work undertaken through the Aboriginal Subsistence Whaling caucus and asserted the need for food security, cultural diversity and sustainable livelihoods for coastal and marginal peoples. It also wished to ensure that the rights of aboriginal people are maintained and stated that the proposal (IWC/64/10) met the Commission's and Scientific Committee's established standards. St Kitts and Nevis encouraged the economic development of whalewatching, but reiterated the right of St Vincent and The Grenadines to utilise the resources of their Exclusive Economic Zone in the way in which they see fit.

Iceland indicated its support for sustainable whaling based on science, and noted that in Iceland in the Bay of Faxaflói both whaling and whalewatching coexisted side by side and had done so for at least 10 years. Palau indicated its support for the proposals in IWC/64/10 on the basis of the Scientific Committee's advice.

The Dominican Republic felt that in the Caribbean issues relating to humpback whales were being considered from different points of view. Twenty five years ago the Dominican Republic had created a whale sanctuary which was visited by around 40,000 people and generated nine million dollars during the season. In contrast, St Vincent and The Grenadines had entered the IWC 25 years ago, alleging an aboriginal subsistence requirement. However they had broken many standards in hunting for young whales or mothers, and the Dominican Republic also highlighted that there had been no aborigines in the Caribbean for over 300 years. For these reasons, the Dominican Republic could support the needs of the native populations in the USA and Russian Federation, but could not support the joint proposal made by all three countries. Ecuador highlighted the prosperity of its own whalewatching activities and indicated it could not support the St Vincent and The Grenadines proposal as it was not aboriginal subsistence whaling and not a priority for human survival, as it amounted to only one or two whales per year. Instead, Ecuador asked St Vincent and The Grenadines to withdraw its proposal and focus on non-lethal use which would be of greater benefit to its citizens.

Mexico highlighted improvements in the state of the Bering-Chukchi-Beaufort stock of bowhead whales and congratulated the achievements of the Alaskan Eskimo Whaling Commission. It stated that the Russian Federation also complied with the requirements and the definition of aboriginal subsistence whaling as established by the Commission. However Mexico expressed its dislike of the inclusion of the St Vincent and The Grenadines proposal within the same package since this whaling was not carried out by aboriginal peoples, and was in fact closer to commercial whaling than to aboriginal whaling. In light of this, Mexico offered assistance to St Vincent and The Grenadines to support the establishment of a whalewatching industry.

Colombia, Chile, Argentina, Peru and Brazil believed that the specific request from St Vincent and The Grenadines should be dealt with separately since there had been no timely response by St Vincent and The Grenadines to the requests arising from the Scientific Committee. These countries also expressed their concern as to whether the hunt was aboriginal in nature. Chile repeated its request to resolve the question of moving to biennial meetings prior to deciding on future ASW quotas. Costa Rica stated that it was unable to identify a real interest by St Vincent and The Grenadines to follow Scientific Committee requests and collect data and submit catch return information in a serious and systematic manner. Costa Rica also expressed reservations regarding the aboriginal nature of the St Vincent and The Grenadines hunt, and suggested that although whale hunting was practiced in many countries during the 18th and 19th centuries the world had now evolved and non-lethal uses of whales provided more effective ways of generating an economic income.

Cyprus spoke on behalf of the other European Union member states party to the IWC to express support for the proposed Schedule amendment. It stated that the EU and its member states were committed to protecting the lives of indigenous peoples including the protection of livelihoods. It noted that in considering further proposals for ASW they would be guided by the precautionary principle and by the advice of the Scientific Committee and also taking into account the work of the IWC's ASW Working Group. South Africa, supported by Switzerland and Israel, supported the proposal contained in IWC/64/10 and South Africa sympathised with people who depended upon subsistence whaling and said that while the development of alternative livelihood programmes such as whalewatching were helpful they could not solve all of the problems involved. Monaco stated it would not interfere with building consensus on IWC/64/10 but highlighted the relatively recent development of whaling practices in St Vincent and The Grenadines and questioned whether this was compatible with the concept of aboriginal whaling. Monaco requested that in the future a historical account be provided to help shed light on the development of this particular hunt.

The Eastern Caribbean Coalition for Environmental Awareness (ECCEA) said that never in the history of archaeology in St Vincent and The Grenadines had there been any findings to suggest that the aboriginal Kalinago or Garifuna peoples killed whales, interacted with whales or ate whale meat. The killing of humpback whales on Bequia was a relic of European and American origin which was begun in about 1875 by a Scottish settler, William Wallace, together with a settler of French origin Joseph Ollivierre. ECCEA highlighted that the whaling was not an 'aboriginal' activity, it was learned from the Yankee whalers and modern day whaling in Bequia was done by persons of mixed European and African descent. ECCEA went on to say that the killing of humpback whales on Bequia could not be justified on economic or nutritional grounds as alternative sources of protein including chicken and fish could be obtained at cheaper prices on Bequia. It highlighted the negative impact on the tourism industry caused by the killing of whales. ECCEA said that the Bequia whalers had a long tradition of hunting mothers and calves in contradiction to IWC regulations, and that the St Vincent and The Grenadines government had a history of non-compliance with respect to IWC reporting obligations. It called on the IWC to withdraw the proposal for a take of humpback whales for St Vincent and The Grenadines.

Te Ohu Kaimoana is the body established to manage and advocate Maori rights to fisheries in New Zealand and it said that one of life's great delusions is when we believe that our way of doing things, whether religion, economy , justice and in particular looking after the environment, is better than that of somebody else. It saw the Commission behaving today in the same way that the English behaved when they arrived in New Zealand in introducing a new range of ideas, systems and systematic gross exploitation of natural resources. Te Ohu Kaimoana said that indigenous peoples were not gross exploiters, and that it was ironic that countries that had previously grossly exploited whales were now imposing newly acquired values on cultures that continue to suffer the effects and symptoms of colonial exploitation. It was concerned that indigenous peoples may not be able to maintain their rights and exercise their traditions in ways that preserve their dignity, and reducing those groups to seeking permission was degrading. It noted that the Commission was already a tool for limiting indigenous tradition through its quotas, and requested that indigenous people be allowed to continue to practice their traditions and customary rights.

At the end of the debate the Chair asked if there was consensus to adopt the Schedule amendments as given in IWC/64/10. Following brief discussions, Brazil and Mexico spoke on behalf of the South American group of countries to report that there was consensus to adopt the Schedule amendments as related to the USA and Russian Federation proposed catches of bowhead whales and gray whales. But there was no consensus agreement to accept the proposed amendment in relation to the humpback catches of St Vincent and The Grenadines. In response to an invitation from the Chair, the USA clarified that the Governments of the Russian Federation, St. Vincent and The Grenadines and the USA opposed efforts to divide the joint proposal in IWC/64/10. It noted that the proposals were all a status quo continuation of existing hunts, and all had been found to be consistent with the IWC's definition of ASW on previous occasions. Further, the Scientific Committee had reported that the hunts were sustainable, and for these reasons these Governments considered that it was appropriate for the Commission to consider a joint rather than a separate proposal.

Following this explanation, the Chair recognised there was no consensus on the joint proposal and requested the Commission decide by vote. The outcome of the vote was that the Schedule amendment contained in IWC/64/10 was adopted with 48 votes for, 10 against, 2 abstentions and one not participating[16].

After the vote Mexico explained that it voted in favour of the quota requested by the USA and emphasised that while the indigenous people of Mexico do not utilise whales for cultural or subsistence needs, Mexican national legislation and the commitments included in international conventions to which Mexico is a party required it to safeguard the rights and promote the knowledge and the culture of indigenous people. With its vote in support of the ASW quota for the Eskimos of Alaska, Mexico recognised the important contribution made by the Eskimo people to promote the growth of the Bering-Chukchi-Beaufort stock of bowhead whales so that it is no longer endangered. Accordingly, Mexico added its appreciation to the Alaskan Eskimo Whaling Commission, the North Slope Borough, and the Alaskan Wildlife Management Department and the Scientific Committee for providing continued and detailed data and records for the last 30 years. Mexico went on to explain that it voted in favour of the request put forward by the Russian Federation for its Eskimo communities because it is consistent with the definition of ASW adopted by consensus in the IWC in 2004. Furthermore the quota requested for gray whales was the same annual rate as that for the last five years. It supported the approval of this quota based on the Scientific Committee´s recommendation, which advised that the estimated gray whale population is of approximately 20,000 individuals and with a positive growth rate, so that the requested quota does not affect the gray whale stock. Regarding the quota request on behalf of St Vincent and The Grenadines, Mexico explained that it would have opposed this quota because while there was precedent of approval of quotas for that country, there were persistent problems that have been unresolved for over three decades and those problems were related to the lack of sufficient information on the history and continuity of this whaling activity and how they respond to nutritional and socio-cultural needs. This information was necessary to evaluate the declaration of needs for humpback whales. Additionally Mexico encouraged Saint Vincent and The Grenadines to provide information and data in response to the requirements of the Scientific Committee, especially photo identification of the humpback whale individuals and tissue samples for genetic analysis.

India explained that it had abstained because of its position that subsistence whaling should be phased out in the due course of time because of the changing socio-economic and cultural requirements of the Communities. Panama explained that it rejects commercial whaling and supports the moratorium. It understood that aboriginal subsistence whaling was the only acceptable whaling so long as it complied with scientific advice and the creation of needs and that it was not used as a context for commercial whaling. This was why it supported the request made by the USA and

[16] Voting records are listed in document IWC/64/Status available at www.iwcoffice.org/iwc64docs

Russian Federation, but its preference would have been for the St Vincent and The Grenadines request to have been dealt with separately. Costa Rica clarified that it supported the USA and Russian Federation requests, but had voted against the proposal because there was a need to promote conservation and changing customs for St Vincent and The Grenadines. India, Monaco, Uruguay, Colombia, Dominican Republic, Peru, Argentina, Ecuador and Chile recognised the progress that had been made with ASW by the USA and Russian Federation, but would also have liked the quota request for St Vincent and The Grenadines dealt with separately.

7.5.2 Proposed catch limits for the Greenlandic hunt

Denmark introduced document IWC/64/12 which was a proposed Schedule amendment submitted by Denmark on behalf of Greenland. Denmark explained that the Schedule amendment was supported by two other documents, these being IWC/64/ASW7 which was a white paper on the management and utilisation of large whales in Greenland and IWC/64/ASW8 which was a note on the Greenland needs statement.

Regarding the concept of needs, Denmark explained that these were established by the Government of Greenland and had been the same for the last 20 years, namely 670 tonnes of whale meat on the West Greenland side. This figure was calculated after taking into account the needs of food security and the opportunities to use other food sources including fish, birds, caribou, musk ox, polar bears, walrus, sheep and imported food. The figure equated to 12-13kg of whale meat per inhabitant per year, and Denmark stated that there was no intention to introduce a policy defining those allowed to eat whale meat and those not allowed to eat whale meat.

The Chairman of the Fishermen and Hunters Organisation stated that whaling had always been an important part of the cultural life in Greenlandic society, and that rational utilisation of resources and social and economic well-being is an integral part of the hunter's daily situation. It said that the 2007 UN declaration on the rights of indigenous peoples could be violated if a positive solution could not be reached on the proposals contained in IWC/64/12, and also noted that the Scientific Committee had once again agreed that the quota request would not harm the stocks. Regarding the concern expressed by some Contracting Parties on the question of money, it said that today all activities involve money, and without it there was no possibility to conduct a proper effective fast kill of whales.

The Greenlandic Ministry for Fishing, Hunting and Agriculture used a PowerPoint presentation to provide an introduction to the geography and industry of Greenland which emphasised the remote and inaccessible nature of the territory and the reliance on natural resources including minerals and biological resources such as fish, seals, whales, terrestrial mammals and seabirds. Referring to the whale hunt, Greenland showed that hunting methods had been continually improved and data had been submitted to IWC on killing methods. The presentation also addressed: (1) the nature of the humpback whale resource and the possible opportunity costs associated with tourist based whalewatching in some parts of the Caribbean; (2) the sampling protocols and data collection methods associated with the utilisation of large whales in the Greenlandic hunt; and (3) the local consumption and distribution of whale meat in Greenland. In addition, a full description of the regulation, control and monitoring of the Greenland hunt was provided in Chapter 5 of IWC/64/ASW7.

Denmark/Greenland concluded its introduction by confirming that the annual need of meat from large whales in the Greenland hunt was 670 tonnes and this had been estimated by the Technical Committee and the Aboriginal Subsistence whaling sub-committee in 1991. However this level had never been met by the catch limits allocated by the IWC. Regarding scientific advice, the Scientific Committee had, for the first time, been able to give interim advice for all four whale species relevant to Greenland in 2008, and this advice was valid for two quota blocks until 2018 and the recommendation was that a hunt of 178 minke whales, 2 bowhead whales, 19 fin whales and 10 humpback whales off West Greenland and 12 minke whales off East Greenland would not harm the stock.

COMMISSION DISCUSSIONS AND ACTION ARISING

Norway, St Lucia, Japan, Iceland, St Kitts and Nevis, St Vincent and The Grenadines, Switzerland, Russian Federation and Antigua and Barbuda supported Denmark/Greenland's proposal.

Norway and Iceland stated their view that they recognised only one type of whaling, and that was sustainable whaling irrespective of form or place. Given the clear advice from the Scientific Committee that the quotas were sustainable Norway and Iceland supported the proposal in IWC/64/12. Iceland highlighted that the present quotas do not fulfil the needs of the Greenland people and so it supported the increased quota proposal compared to 2008-2012 levels. St Lucia highlighted the issue of food security and that Greenland is unable to provide food for its people through traditional agriculture and as such is dependent upon the use of marine resources. It also stressed that denying the quota request may cause additional stress on other marine mammal resources including small cetaceans which would be targeted to satisfy nutritional needs, and that disregarding the substantial work and recommendations of the Scientific Committee was to set a bad precedence. St Vincent and The Grenadines expressed its support for the Denmark/Greenland proposal and remarked that the sustainability of the hunt was of key importance. It considered that the people of Greenland should be able to determine their own use of marine mammal resources.

Japan emphasised the Scientific Committee advice that the proposed catches would not harm the stock and that the need and circumstances for the hunt had been fully described. Switzerland referred to the declaration on the rights of indigenous peoples, and highlighted the need to maintain institutions, cultures and traditions and the ability to engage freely in all traditional and economic activities. The Russian Federation referred to the traditional use of whale meat in supporting the subsistence, economic exchange and growth of arctic aboriginal communities. It highlighted the need for Greenland to continue working within the frame of the IWC, instead of outside it as two other countries (Canada and Indonesia) already did. It suggested that the strategy of isolating the requirements of Greenland was not in the best interest of the IWC or the well-being of aboriginal nations.

The USA indicated its support for Denmark/Greenland's proposal and noted the Scientific Committee's conclusion that the catch limits would not harm the populations. The USA believed that the use of whale products by the hunters in Greenland satisfies the definition of ASW agreed by the IWC.

The Dominican Republic, supported by Ecuador, highlighted its concern that humpback whales in the Atlantic were easy to catch given their tradition of getting close to whalewatching vessels around the Dominican Republic. It also noted concern that only a limited amount of data on the weights and yields of captured whales had been recorded by Greenland and that there were only nine whaling inspectors for 18 communities despite it being a stated priority for Greenland. It contrasted this with the regulation of whalewatching in Dominican Republic where 33 employees supervised activities. It also noted other weaknesses in the Denmark/Greenland paper including levels of pollutants in whale meat and its unsuitability for consumption by pregnant women or children. Brazil and Ecuador considered that the Denmark/Greenland proposal did not meet the definition of Aboriginal Subsistence Whaling because of its strong commercial component. Brazil also highlighted the difficulties in developing a multi-species *SLA* in order to satisfy the Commission's objectives for ASW hunts, and requested the Scientific Committee be allowed the necessary time to develop its full advice before adopting the quota. Argentina referred to the concern expressed at the Scientific Committee meeting about the insufficient level of detail provided by Denmark/Greenland in regards to the conversion factors used to calculate yield of meat from each whale, and inconsistencies with the sampling efficiency and weighing procedure. It highlighted the Scientific Committee recommendations regarding sampling protocols and methods for measuring the lengths of animals caught.

Australia noted the requests to move towards consensus but stated the proposal was about the abandonment of consensus rather than a move towards it. It recalled that at the 2010 meeting a consensus had been arrived at with difficultly, and a number of conditions were placed on that consensus and undertakings made which had not subsequently been met to the satisfaction of the Scientific Committee. Australia noted that the Chair's report from IWC/62 in 2010 stated that by returning the humpback whale to the mix of resources that Denmark/Greenland would be able to reduce the overall number of whales taken because of the greater yield provided by humpback whales. Therefore during the agreement of the consensus decision Greenland had stated that there would be an opportunity to lower the number of whales taken, but now the Commission was being asked to accept a Schedule amendment whereby the number of whales taken would rise. Australia stated it could not support the Schedule amendment as previous undertakings must be honoured and that the Commission should not be confronted with a new level of ambit. New Zealand re-iterated its support for ASW where it is consistent with the Scientific Committee's findings on sustainability, where it does not threaten the rebuilding of endangered populations and where it meets the criteria set by the IWC. It stated that like Australia it was not prepared to support an increase in the quota from what was agreed with such difficultly two years ago. India stated that the present proposal for increasing quota is not supported by adequate studies on the assessment of the increased need for meat by the aboriginal communities. It also noted NGO reports that not all the meat was used by the aboriginal communities and some was used by restaurants.

Chile re-iterated its concern that the quotas were proposed for six years in the absence of agreement on a possible move to biennial meetings and it requested a commitment to discuss renewal in 2017 if the move to biennial meetings was not successful. It also highlighted its concern arising from the Scientific Committee's views on the lack of information provided and the non-rigorous nature of the way the hunt was controlled. It also noted its concern that the selling of meat to tourists in restaurants struck against the moratorium on commercial whaling and as such it could not support the proposal. Mexico indicated its concern about commercial use being made of quotas given the language in the Schedule that ASW is permitted only when the meat and products are used exclusively for local consumption and that this was not happening. It understood that whale meat was a source of livelihood in remote settlements but there was no need to provide this resource for the whole population including the 80% residing in urban areas. It also drew attention to the absence of data on the percentage of meat being used by local communities compared with the percentage being sold on the free markets, and the absence of information on protein sources from the flourishing fishing industry.

Cyprus spoke on behalf of Austria, Belgium, Czech Republic, Estonia, Finland, France, Germany, Ireland, Italy, Luxembourg, The Netherlands, Poland, Slovenia, Spain, Sweden and the UK and re-iterated their full commitment to ASW to satisfy aboriginal needs in the wider context of protecting the rights of indigenous peoples and their livelihoods. It explained that they were ready to consider ASW proposals according to these principles and were pleased to have supported the proposal introduced by the USA, Russian Federation and St Vincent and The Grenadines, but that they were unable to support the proposal described in IWC/64/12.

Denmark/Greenland responded to the concerns raised and stated that the commercial part of the ASW hunt had been fully explained. It had asked hunters to buy cannons and grenades to improve the humaneness of the hunt and these cost 2000 dollars apiece and were financed from the proceeds of the hunt as sold by the citizens of Greenland. In relation to the possible move to a biennial meeting cycle, Denmark/Greenland stated it would adjust to whatever decision was taken. In relation to the possible reduction in the number of whales taken following the addition of humpback whales to the mix in 2010, Denmark/Greenland noted that the addition of the humpback whales had been matched by an equal reduction in the number of fin whales. In relation to the control of the hunt, Denmark/Greenland stated that it had new regulations on the management of large whales in Greenland and an executive order was also being revised. It had strict regulations that every hunter must apply for a license and after having caught a whale they have to stamp the licence before distributing the whale.

Recognising that there was no agreement to adopt the proposed Schedule amendment by consensus, the Chair agreed to Denmark's request to decide the proposal by vote. The outcome of the vote was 25 for, 34 against and 3 abstentions, and consequently the proposed amendment was rejected.

Following the vote, Iceland commented that it was sad for all sustainable whaling countries to witness the result of the decision and said that the organisation had become extremely dysfunctional. Japan also considered that this was a sad conclusion which deprived people living in harsh climates of an important source of nourishment. It considered that the proposal was backed by science, and those who had said no to the proposal did not believe in science. Palau remarked that the IWC had deprived Greenlanders of their main source of protein and protected marine mammals against human beings. It conveyed its regrets to Greenland on behalf of the likeminded sustainable group of countries. Tanzania remarked that the Denmark/Greenland proposal had been based on science, and asked if members would agree to giving Greenland a timeline to address the issues that had been raised while allowing them to continue with the aboriginal hunt. Switzerland recognised the rights of indigenous people to make use of their natural resources and make their own decisions. It was also Switzerland's wish that the Commission work in the spirit of compromise and that it worked towards solutions which took into account all the opinions expressed.

St Kitts and Nevis said that coastal communities should never be deprived of their rights to their resources. It considered that this was a regretful day for the IWC and asked for reflection on the consequences for the people of Greenland. St Lucia noted that the proposed Schedule amendment had not been for a zero quota, but instead was for a specific quota. Given that the previous quota was expired, it commented that what the Commission had actually said to Denmark/Greenland was to go forth and manage their fishery on their own. It considered that whaling would continue despite the outcome of the vote because the outcome effectively meant no quota advice was given. St Vincent and The Grenadines commented that the Commission had failed to understand the difficulties faced by coastal peoples and said that the IWC was about whales, not people. It said that the organisation was becoming more polarised and emphasised with the people of Greenland in their struggle for their right to food.

Mexico recognised the problems related to Greenland's geography and culture, as well as the difficulties associated with the different species of whales utilised in the aboriginal hunt and the problems regarding the applicability of the declaration of needs based on conversion factors. At the same time, Mexico also shared the reservations and concerns previously expressed regarding the proposed hunt and had therefore voted against it. In this regard, Mexico invited Denmark/Greenland to continue collaborating with the IWC, especially in response to Scientific Committee recommendations regarding the provision of information and data on the amount of edible products of the fin whales, bowhead and humpback whales, as well as to provide information on its sampling programme and data validation protocols. It underlined the Scientific Committee's concern on the insufficient level of data provided by Greenland, the inconsistencies of its report, the efficiency of the sampling regime and the extrapolation procedure and invited Greenland to provide data regarding field protocols, sampling strategies, analytical methodologies and information on the sex and length of hunted animals. Mexico would maintain a careful follow up on the evolution of this case with an open and cooperative attitude, based on IWC principles, objectives and criteria.

Ecuador recognised the importance of the culture and traditions associated with ancestral peoples and noted that its own conservation traditions are reflected in its national legislation and external policies. Ecuador explained that it had opposed the proposal because it had a significant commercial component and exposed consumers to undetermined health risks. In particular, Ecuador could not support the proposal because it affected humpback whales which were a symbol for all countries that had turned whalewatching into a great industry.

New Zealand, supported by Monaco, re-iterated its support for ASW in that it satisfied the Commission's requirements regarding sustainability and need. It commented that the issue of need was especially problematic for Greenland which had access to the social and economic support structures of the Kingdom of Denmark. New Zealand stated that its position had been determined by the effort over the last five years by Greenland to progressively rank up its whaling catch and to insist that the Commission be implicit in the exercise. Five years ago there had been no agreement and a special meeting was required. A special attempt was then made at IWC/62 in 2010 to reach a conclusion which included being complicit in a scenario by which Greenland had finally been able to get what it wanted. It would have been possible for Greenland to have rolled over the same level of quota that was agreed only two years ago, and New Zealand thought it would have been sensible for Greenland to have done that and wished it had asked for it. Monaco remarked that Greenland has the advantage to be surrounded by very rich oceanographic waters, and Greenlanders are a major consumer of seals ranked second in the world just after Canada. There is a variety of food available in their diet, including terrestrial food because Greenland is not just covered entirely by an ice cap, it has farms, sheep, reindeers and vegetables. It consumes also plenty of fish. It said the issue of whale meat being available to tourists, increasingly in a large number of restaurants did not make the case of Greenlanders particularly strong. Finally, Monaco highlighted the health risk linked to methyl mercury which is extremely high in the northern Greenland population being 200 times above the tolerable level advised. In conclusion, Monaco was not in a position to support an increase in quota this year.

India said that it endorsed ASW provided that it was based on assessment of the dietary and cultural requirements of the aboriginal communities and that there was no commercial use of the hunt. It explained that it did not support the increased quota proposed in IWC/64/12 because there was no information on the increased population of aboriginal communities and the requirement for the increased harvest.

Denmark thanked the countries that had supported Greenland and commented that a number of countries had not wished to take responsibility for whaling in Greenland. It regretted the lack of solutions and the lack of understanding and commented that this was a serious situation given the IWC had to work hard to survive at a time when it had not been able to fulfil its obligations under the Convention. It repeated that it fully supported the sustainable use of all marine resources, and that it would now return home to make a sensible decision as to its future course of action.

8. CONSERVATION COMMITTEE

The Conservation Committee met on 26 June 2012 and was chaired by Lorenzo Rojas-Bracho (Mexico). Delegates participated from 25 Contracting Governments and its report is given as IWC/64/Rep5. The Conservation Committee's discussions on Conservation Management Plans, whalewatching and whale sanctuaries and included under Agenda Items 9, 10 and 4 respectively. Discussions on the Committee's other items are summarised below.

At the start of its meeting the Committee rose in appreciation and applause for the life and achievements of Alexandre de Lichtervelde who died in 2011. Alexandre had been Commissioner for Belgium since its adherence to the IWC in 2004. As well as being a strong advocate for the Commission's conservation work he had founded the Ship Strikes Working Group and had been a strong supporter of the online database for recording ship strikes established in 2009.

8.1 Investigation of inedible 'stinky' gray whales

8.1.1 Report of the Conservation Committee

The Russian Federation presented a report (IWC/64/CC10) of a study of contamination problems in gray whales carried out from 2005 to 2011. In 2011, two of the 126 gray whales landed were considered 'stinky'. The study did not draw conclusions on the cause but the authors commented that the 'stink' may be a result of slow metabolism of petroleum hydrocarbons. In addition they found that persistent organochlorines such as DDT were present in only low concentrations or were non-detectable. Stinky whales cannot be used for human or animal consumption as they are abhorrent and cause allergies and diarrhoea. Accordingly the Russian Federation consider them as struck and lost rather than part of the landed quota.

The USA indicated that it was willing to assist the Russian Federation with the experimental designs and analysis needed to make progress with this problem. The Committee thanked the Russian Federation for its report and supported further work on this subject.

8.1.2 Commission discussions and action arising

There were no discussions under this Item.

8.2 Ship Strikes

8.2.1 Report of the Scientific Committee

The Scientific Committee highlighted particular concern where ship strikes affected small populations of whales, especially Arabian Sea humpback whales and southern right whales off South Africa. The Committee had also discussed the outcomes of several recent non-IWC workshops focussing on ship strikes which had been held in London and Cambridge.

The Committee discussed the development of the IWC global database of incidents involving collisions between whales and vessels. Since there had been only a few reports entered onto the database it agreed a more pro-active approach was required. Accordingly it had requested a data co-ordinator position be established through the research budget.

8.2.2 Report of the Conservation Committee

This year there was no report from the Ship Strikes Working Group because of the sad loss of its Chair, Alexandre de Lichtervelde.

The Committee highlighted that the issue of ship strikes is important because it is essential for healthy whale populations, for the recovery of whale populations and for the development of Conservation Management Plans.

The Committee reviewed the work of the technical expert (David Mattila) who had been seconded to the Secretariat to work on entanglement response and ship strikes. Mr Mattila represented the IWC at an international technical workshop on the criteria for determining human-caused lethal impacts to marine mammals held at Woods Hole, USA in 2012. The findings of the workshop would be very helpful to the IWC in finalising criteria for ship strike impacts in the database handbook. The Committee thanked Mr Mattila for his work and efforts to publicise the ship strikes database and thanked the USA for their assistance in supporting Mr Matilla's secondment. It also recommended that Mr Mattila should collaborate closely with the ship strike data co-ordinator proposed by the Scientific Committee, and that a dedicated outreach programme should be established to promote the existence of, and stimulate the use of the database. Other members of the Conservation Committee supported the need for the database co-ordinator but stressed that this should be discussed in the context of other items being considered by the Committee.

The Conservation Committee received reports from countries on ship strikes which had occurred in the last 12 months and on initiatives to record and reduce ship strike incidents. In particular the USA introduced two new proposals which were submitted to the International Maritime Organisation (IMO) in 2012 to amend two existing Traffic Separation Schemes (TSS) off the USA west coast to reduce the likelihood of ship strike deaths and serious injury to blue and other large whales.

PANAMA TRAFFIC SEPARATION SCHEMES

The Conservation Committee received a proposal from the Republic of Panama for the establishment of Traffic Separation Schemes (TSS) and prevention of vessel collisions with whales. Around 17,000 commercial vessels transit the Gulf of Panama each year, and this number has nearly doubled in the last 15 years and is expected to continue increasing as the canal is further expanded.

The Panama Maritime Authority in conjunction with the Panama Canal Authority, the Maritime Chamber, the Smithsonian Tropical Research Institute and the Marviva Foundation had been working for several months on designing four two-way TSS, three for the Pacific and one for the Caribbean, to be presented to the IMO for their endorsement. Panama had recorded 13 whale casualties in two years, mostly of humpback whales. The TSS will be established in areas heavily used by several species of cetaceans, especially humpback whales from both the Northern and Southern Hemispheres which winter in Central America and Panama (up to ~300 individuals per season from the Southern population visit the Las Perlas Archipelago). Based on a temporal and spatial analysis of whales tagged with satellite transmitters and AIS transmissions from over 800 vessels it was estimated that implementation of the scheme would reduce the potential areas of collision between ships and whales by approximately 93%. Panama welcomed any support or recommendations by the IWC and individual countries.

TENERIFE WORKSHOP IN OCTOBER 2012

Spain presented its proposal (IWC/64/CC18) to hold an intersessional workshop on maritime transport and biodiversity conservation. A specific aim of the project is to study and mitigate accidents affecting marine biodiversity, especially the impacts on cetaceans and to develop a programme of training and communication for the maritime transport industry.

WORKSHOPS ON DISENTANGLEMENT RESPONSE AND SHIP STRIKE REDUCTION IN THE WIDER CARIBBEAN

The USA summarised its joint proposal with the Dominican Republic, France, Mexico and Panama (IWC/64/WKM&AWI 12) for the IWC to work with UNEP, CEP and SPAW to conduct a series of three workshops on disentanglement and ship strikes in the wider Caribbean, focusing on an interdisciplinary ship strike workshop planned for 2013. This item was discussed in more detail by the Working Group on Whale Killing Methods and Associated Welfare Issues. The USA hoped to expand partnership for this effort to other interested IWC parties and the IMO. The USA recognised that this proposal originated from Alexandre de Lichtervelde's work and his communication with UNEP and SPAW.

France, the Netherlands, Argentina and Mexico expressed support for the workshops and the Netherlands noted that it would be happy to participate and would look into the possibility of making a financial contribution.

An observer from UNEP and SPAW-RAC expressed strong support for the proposed workshops on entanglement and ship strikes noting that the French Agoa sanctuary for the protection of marine mammals is also supportive and will bring technical, logistical and financial support to the proposal. In relation to vessel strikes, the marine mammal action plan approved by the SPAW parties on threats to marine mammals in the wider Caribbean region states the following key objectives.

(1) *Improve understanding*. To identify high risk areas for vessel strikes in each country.

(2) *Impact assessment.* To assess the magnitude of vessel strikes in the Wider Caribbean Region.

(3) *Impact minimisation*. To stimulate on-going and initiate new actions at the regional, national and local level to reduce the frequency of vessel strikes.

The Conservation Committee thanked the UNEP and SPAW-RAC representative for the offer of collaborative engagement and the Secretariat looked forward to formalising the agreement in the coming months.

STRATEGIC PLAN

The Conservation Committee endorsed a suggestion from the Chair to develop a strategic plan for ship strikes which might include data gathering and mitigation. Belgium considered that a strategic plan would help to ensure the effectiveness of the IWC ship strikes database.

APPOINTMENT OF CHAIR FOR THE SHIP STRIKES WORKING GROUP

The Conservation Committee was pleased to appoint Belgium as Chair of the Ship Strikes Working Group and acknowledged the work of Alexandre de Lichtervelde and of Belgium on ship strikes in the past.

8.2.3 Commission discussions and action arising

Cyprus spoke on behalf of the EU member states to note its concern regarding the increased anthropogenic threats which faced cetaceans including bycatch, habitat degradation, pollution, overfishing, climatic change and underwater noise. Additionally marine debris was now recognised as a growing threat to large whales and small cetaceans through ingestion and entanglement. Cyprus understood that the IWC had led efforts to investigate and mitigate the effects of ship strikes. It stated that ship strikes were happening regularly in all oceans and they are also connected to other threats facing cetaceans because once a whale is entangled in marine debris it may become more susceptible to a collision with a ship. Also wounds inflicted by ship strikes may be infected by a variety of pathogens. Greater effort was needed to understand and mitigate the risk to cetaceans and the IWC could play a significant role both in terms of direct action, undertaking research and reaching out to other fora to co-ordinate responses. Cyprus also recognised the considerable contribution made by the IWC's Scientific Committee to research on small cetaceans. This work referred both to capacity building and conservation for highly endangered species. EU member countries had repeatedly made contributions to the voluntary fund for small cetacean conservation research to underline the importance of this line of thinking. Cyprus was convinced that this work would continue to be important in the future.

France acknowledged the statement by Cyprus and drew attention to its own efforts to reduce ship strikes through work in the Pelagos Sanctuary in the Mediterranean and the Agoa Project in the Caribbean where ways were being sought with the IMO to reduce vessel strikes. In addition France supported and would continue to contribute to workshops held in conjunction with the IWC and other states on the disentanglement response to whales within the Caribbean. With regard to ship strikes, France emphasised the importance of improving data collection within the IWC and the added value of sharing information on strikes with organisations such as ACCOBAMS and ASCOBANS.

The Netherlands welcomed the initiative for a series of workshops dealing with the problems of ship strikes and entanglement response in the Caribbean. This issue was of direct relevance to The Netherland's overseas territories and it was pleased to be a member of the group of countries supporting the workshops. The Netherlands recorded their intention to financially support the organisation of the workshops.

Panama was pleased that the Committee had been able to meet for a full day. It thanked those delegations who had shown support for the TSS proposals in Panamanian waters and remained open to further suggestions on how to continue with this project. Panama thanked the other co-sponsors of IWC/64/WKM&AWI 12 and indicated it was pleased to support the efforts to hold workshops on ship strike and entanglement reduction in the wider Caribbean region. Argentina supported the recommendations of the Conservation Committee as regards ship strikes and in particular it emphasised the work done by Panama to improve the management of navigation. It requested Panama to present its work to next year's Scientific Committee meeting. Although Argentina is not part of the Caribbean it expressed its interest in the proposals for workshops to address entanglement response and ship strikes with UNEP, as the collaborative work would strengthen both the partner organisations and the IWC. Ecuador recorded the high value it placed on work to reduce ship strikes.

Australia emphasised that the way to reduce the likelihood of ship strikes was through the use of appropriate and up to date data. However currently not all ship strikes were reported and Australia highlighted the need for all Contracting Parties to make such reports where strikes arise within national waters. Australia also stressed the need for a ship strikes data coordinator and indicated its full support for this position. Belgium supported Australia's comments on the essential importance of collecting data regarding ship strikes. It considered that the database co-ordinator should also take on the role of raising awareness of the database and establishing links with other industry and IGO conservation bodies so as to further the IWC's work on this topic.

The USA stated its support for the Conservation Committee as its work reaffirmed the conservation objective of the Convention and improved the governance of the Commission's conservation initiatives. It encouraged all countries to participate. The USA provided an update on the proposed TSS for the west coast of the USA and indicated that it expected the IMO's Navigation Sub-Committee to approve the proposals in the near future. Regarding the proposals for a series of workshops addressing ship strikes and entanglement response in the wider Caribbean, the USA thanked all the co-sponsors and especially The Netherlands for their offer of financial support

Spain referred to a workshop that will take place in October 2012 in Tenerife to discuss maritime transport and biodiversity conservation, especially cetaceans, in the framework of a European project called Life Plus. Participants will include the maritime traffic industry, marine scientists, whalewatchers and other stakeholders including the International Maritime Organisation. The workshop will have an agenda to provide communication tools and systems for educating sailors about the steps to be taken to prevent risk to whales and also other marine life and habitats.

The Commission noted the Conservation Committee's report on this Item and endorsed its recommendations.

8.3 Southern Right Whales of Chile-Peru

8.3.1 Report of the Scientific Committee

An IWC Workshop on southern right whales was held in Buenos Aires, Argentina, 13-16 September 2011. The results of this Workshop were presented to the Scientific Committee (SC/64/Rep5) which concurred with their recommendations, in particular those to help clarify the status of this critically endangered species and also to help identify any threats and possible mitigation measures. The Workshop recommended that surveys, photo-id and genetic studies should be conducted.

8.3.2 Report of the Conservation Committee

The Conservation Committee reported that mobile technology is being used in joint work between the Chilean Navy and the NGO Centro de Conservacion Cetacea to enable sightings of southern right whales to be reported in real time. Given the critically endangered status of this population it was requested that this item remain on the agenda of the Conservation Committee.

8.3.3 Commission discussions and action arising

Chile and Peru reiterated their commitment to the conservation of this critically endangered population. Chile drew attention to the development of the Conservation Management Plan[17] and expressed its desire for international cooperation to ensure the long term protection of the species. Peru noted it had only a few records of this species from its national waters but in accordance with the reports of the Scientific and Conservation Committees, Peru was supportive of all efforts to ensure the conservation and viability of this whale species.

The Commission noted the Conservation Committee's report and endorsed any recommendations.

8.4 National Reports on Cetacean Conservation

8.4.1 Report of the Conservation Committee

Several countries had submitted voluntary national cetacean conservation reports: Argentina (IWC/64/CC15), Australia (IWC/64/CC4), Brazil (IWC/64/CC22), Chile (IWC/64/CC21), France (IWC/64/CC14), Mexico (IWC/64/CC20), New Zealand (IWC/64/CC19), UK (IWC/64/CC8) and USA (IWC/64/CC5). The Committee welcomed these reports, many parts of which had been discussed under earlier items. More countries were encouraged to submit reports in future.

8.4.2 Commission discussions and action arising

The USA noted that it would comment on two items addressed in its Conservation Report (i.e. cetacean health and disease and anthropogenic sound) under Item 18 below.

The Commission noted the report of the Conservation Committee on this item and endorsed any recommendations.

[17] See Item 9.1 for a full report of the Conservation Management Plan.

8.5 Marine debris

8.5.1 Report of the Scientific Committee

The Scientific Committee noted that marine debris is a growing concern for marine wildlife in general but its interactions with cetaceans were poorly understood. Accordingly the Scientific Committee reviewed several papers on marine debris and recommended that a workshop on marine debris and cetaceans be held in 2013[18]. The primary aim of the workshop would be to determine how to best quantify the ways in which marine debris was affecting cetaceans and how best to monitor and mitigate for such effects. The workshop could also consider how best to develop a centralised database to collate cases of debris interactions, including the development of standardised criteria for data to allow more certain identification of the types of debris and the interactions involved.

The Chair of the Scientific Committee also referred to the work being undertaken in the USA, Korea and Japan and through the Steering Group for the IWC-POWER cruises who are investigating how those cruises can contribute to international efforts to collect more information on marine debris[19].

8.5.2 Report of the Conservation Committee

Australia suggested that the workshop should be held jointly by the Scientific and Conservation Committees so as to encompass both the scientific and management aspects of the problem of marine debris.

The UK and Australia drew attention to the recent Rio Ocean Declaration (in the outcomes document of 'The Future We Want', para. 163) which called on all nations to take action on Marine Pollution. They commented that the IWC should cooperate with other international organisations to address this threat.

Argentina referred to a paper[20] on the ingestion of plastic debris in 28% of 106 Franciscana dolphins incidentally captured in artisanal fisheries on its northern coast. The USA provided information on a new programme aimed at combating the problem of derelict fishing gear called 'Fishing for Energy' and encouraged interested delegations to join the initiative.

The Conservation Committee endorsed the proposal for a joint workshop on marine debris by the Scientific and Conservation Committees.

8.5.3 Commission discussions and action arising

Australia shared the growing concern that pollution and marine debris posed a significant threat to ecosystems and biodiversity and as such it welcomed the work of the Scientific Committee. The issue of marine debris had been highlighted in the recent Rio Ocean Declaration as being of global concern. Australia welcomed the workshop proposal which it saw as an excellent example of collaborative working between the Scientific and Conservation Committees. It wished to ensure that all threat mitigation efforts were based on good science and acknowledged that a number of other international organisations were already working on this topic and encouraged collaboration between those organisations and the IWC.

Cyprus spoke on behalf of European member states party to the IWC to indicate that it was delighted to participate in the developing work of the Conservation Committee as it considered the many issues facing cetaceans. It commended the work of the Scientific Committee on marine debris and highlighted that cetaceans can be harmed by both entanglement and ingestion of plastics. It said that a number of other Inter-governmental organisations (IGOs) including UNEP, CBD and the Rio Outcome Document had recognised the need for co-ordinated action and encouraged the IWC to participate.

The USA supported the Scientific Committee's recommendations and noted that the UNEP global partnership on marine litter was launched at a side event at the recent Rio+20 Conference. This new partnership will act as a coordination forum to unite diverse organisations and encourage Governments, NGOs and scientists to collaborate. The partnership built on the Honolulu agreement which the USA highlighted to the IWC in 2011[21]. In addition, the USA drew attention to a domestic initiative called 'Fishing for Energy' which allowed fishermen to dispose of derelict fishing gear at no cost. The recovered gear was transported for free to a local energy facility and used as a source of renewable energy.

The United Kingdom noted the work being undertaken by a number of countries to reduce the effects of marine debris and highlighted the recommendations from the Scientific and Conservation Committees that the IWC should co-operate

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[18] See IWC/64/Rep1 Annex K, Appendix 3 for further details.
[19] Further information is provided at IWC/64/Rep1 Annex G.
[20] Denuncio et al. 2011. Plastic ingestion in Franciscana dolphins, *Pontoporia blainvillei* (Gervais and d'Orbigny, 1844) from Argentina. *Marine Pollution Bulletin* 62(8):1,836-841.
[21] See Annual Report of the International Whaling Commission, 2011 p86.

with other IGOs to address the threats. The UK also highlighted its support for the joint Scientific and Conservation Committee workshop.

Austria supported any and all IWC endeavours in the field of marine debris. It recalled that the IWC had recognised several environmental concerns and marine debris spanned three of these: habitat degradation, chemical pollution and fishery interactions. It involved both IWC scientific and technical work, e.g. on entanglement response and the ingestion of plastic. It was one of the most visible and perhaps controllable forms of pollution, ranging from micro plastics to giant nets and Austria therefore supported and was looking forward to the results of the proposed workshop to be held in 2013.

Argentina supported the recommendations of the Scientific and Conservation Committees and highlighted the effect of marine debris on the franciscana. In addition it noted the reports of entanglement events affecting the population of Southern right whales and consequently it wished to see continued action to address the problem of marine debris.

Claire Bass of the World Society for the Protection of Animals (WSPA) congratulated the Conservation Committee on the excellent breadth and quality of its work. WSPA believed IWC should divert a greater proportion of its time and financial resources to its growing conservation agenda and also that the Commission should undertake a review of the work of its Scientific Committee with an aim of affording more time and budget to its conservation work. WSPA spoke on behalf of many NGOs in welcoming the addition of marine debris to the Scientific and Conservation Committee's agendas through a joint workshop. As noted by several member nations this issue already had the attention of several IGOs including the United Nations and it supported the suggestion that the IWC should co-operate to achieve multi-agency solutions. WSPA, the Environmental Protection Agency (EPA), Oceancare, and Pro-Wildlife showed their joint support for the initiative by collectively contributing £17,000 in funding towards this workshop. The Chair and the Chair of the Conservation Committee thanked these organisations for their donation.

The Commission noted the reports of the Scientific and Conservation Committees on this agenda item and endorsed any recommendations.

8.6 Voluntary fund for small cetacean conservation research

The Chair acknowledged the financial support provided to the small cetacean conservation fund from both Contracting Parties and Non-Governmental Organisation observers and noted that much progress had been achieved through the use of these donations.

8.6.1 Report of the Conservation Committee

In 2011 the Conservation Committee received a strong recommendation from the Scientific Committee's sub-committee on small cetaceans for funding nine high-standard research and conservation projects under the Commission's voluntary fund. All of the projects were aimed at improving conservation outcomes for small cetacean species and populations threatened or especially vulnerable to human activities.

The Chair of the Scientific Committee's sub-committee on small cetaceans, Dr Caterina Fortuna, gave an update on the current status of the Voluntary Fund for Small Cetacean Conservation and Research. Contributions received during the past year had enabled all nine projects to be funded and these were outlined through a PowerPoint presentation made to the Conservation Committee. Particular emphasis was given to the conservation and capacity building aspects of each project.

As soon as sufficient additional funding for 2-3 projects was secured a new call for proposals would be launched, possibly by the end of 2012. The UK commended the work being conducted under the Small Cetaceans fund and noted that the IWC must not overlook the conservation of small cetaceans, and applauded the work being done by Mexico to protect the Vaquita. In addition it noted its concern over the continued hunting of Dall's porpoise, highlighted the Scientific Committee's concern over the hunting of Baird's Beaked whales and encouraged the provision of data to assist the efforts of the Scientific Committee in its work.

The Chair of the Conservation Committee congratulated the Scientific Committee on its work and the Chair of the small cetaceans sub-committee (Dr Caterina Fortuna, Italy) in ensuring the successful outcome of the projects.

8.6.2 Commission discussions and action arising

Australia drew attention to the many global threats faced by cetaceans and small cetaceans in particular. The projects being taken forwards under the voluntary fund had a global distribution and focused on critically endangered populations. Australia hoped this work would continue to be supported by contracting parties as it is a manner in which the IWC can make a real and effective contribution towards the conservation of small cetaceans.

The Netherlands expressed its concerned at the lack of protection for many small cetaceans worldwide and favoured a stronger role for the IWC on small cetacean conservation. It welcomed the work undertaken through the Small Cetacean Conservation Fund and announced a voluntary donation of 15,000 Euro to continue the Fund's projects. Italy also recalled its financial contribution to the fund in 2011, and announced a further contribution of 15,000 Euro for 2012. The United Kingdom remarked that the level of support for the fund showed its importance and was delighted to provide a donation of £10,000 GBP to the fund in addition to its contributions from previous years. France recalled that it had supported the fund financially since 2011 and would continue to do so in 2012.

Argentina thanked those countries who had contributed and continued to do so. It said that small cetaceans should be considered as an integral part of the work of the IWC and noted that the new sponsorship had given priority to the small cetacean species and areas where little information previously existed. Monaco congratulated the countries that had contributed to the voluntary fund and hoped that it would be able to do so soon. It recalled its concern at the declining populations of many small cetacean populations and highlighted that the word 'small' was a misnomer as some of the small cetaceans were as large as the small whales. It stated that the IWC should give equal attention to all cetaceans. India stated its support and appreciation for the work of the Scientific Committee and said that small cetacean species should be conserved at any cost. Switzerland welcomed the work of the Scientific Committee on small cetaceans and urged Contracting Governments to take all necessary measures to reduce direct and indirect takes, interaction with fisheries and to restore degraded habitats.

Germany welcomed the tremendous and effective work on the conservation of cetaceans and the financial commitments of the Contracting Parties. Germany is a contracting party to ASCOBANS[22] where a variety of conservation activities were being taken forwards, for example the reduction of noise during piling operations in the construction of offshore wind farms. Germany drew attention to a harbour porpoise survey in the Baltic Sea being conducted jointly with Denmark. This was expected to provide a basis for further conservation measures including fisheries technical measures. In addition Germany proposed a fuller study on harbour propose in the Baltic so as to develop suitable mitigation measures.

Birgith Sloth of the Society for the Conservation of Marine Mammals said that the Conservation Committee had already proven its importance through work on ship strikes and many other threats. All of these affected both large and small cetaceans. Cetaceans were the ambassadors to the sea and many observers found it difficult to understand the damage caused to cetaceans, but when made aware how human activities affected not just the giants of the sea but also their small relatives it led to awareness and concern. The IWC voluntary fund for small cetaceans was an excellent example of how the expertise of the IWC could allow cooperation between Governments and NGOs to ensure better protection of endangered species. It also supported important capacity building and awareness through the communities involved in the projects. The Society for the Conservation of Marine Mammals was pleased to announce that the Danish coalition of NGOs had decided to commit itself to collect and make available funding to support the IWC's work on small cetaceans.

The Commission noted the report of the Conservation Committee and endorsed any recommendations under this agenda item.

8.7 Other

The Conservation Committee noted the report of the Intersessional Correspondence Group on strengthening IWC financing (IWC/64/F&A4) as presented to the Finance and Administration Committee. Financing for projects and research was required for the important work being done across the IWC on issues such as ship-strikes, entanglement, CMPs and marine debris to contribute to the shared IWC goal of healthy whale populations.

Australia raised the issue of cooperation with other organisations noting the Scientific Committee process of agreeing formal IWC observers to attend meetings of other international organisations. Australia requested that the Scientific Committee make reports to the Conservation Committee where the work of such organisations is of relevance to it. In addition it suggested that other organisations whose work is relevant to the Scientific Committee should be identified and a complementary initiative be instituted through the Conservation Committee. Australia volunteered to do some of this work intersessionally.

The Chair of the Conservation Committee announced that Jim Gray (United Kingdom) had agreed to take up the role of Vice-Chair for the Conservation Committee.

[22] The Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas.

9. CONSERVATION MANAGEMENT PLANS

At IWC/63 in 2011 the Commission endorsed a proposal from the Conservation Committee to establish a Standing Working Group on Conservation Management Plans (CMP Working Group). The role of the working group is to provide assistance to CMP proponents and facilitate cooperation between the Conservation Committee and Scientific Committee in areas relating to CMP nomination, development, implementation, monitoring and review.

9.1 Report of the Scientific Committee

ARABIAN SEA HUMPBACK WHALES

The Arabian Sea humpback population had previously been identified by the Scientific Committee as a likely candidate for an IWC Conservation Management Plan. To facilitate this process an Intersessional Working Group was formed at IWC/63 in 2011. Good progress had been made in assembling the documentation required to submit a proposal to the IWC for a candidate CMP. A key component of CMPs was support from a broad range of stakeholders including range state governments and the Scientific Committee welcomed the work undertaken thus far and strongly recommended that discussions between scientists and relevant range state governments continue to further progress the CMP process.

SOUTHERN RIGHT WHALES

At IWC/63 in 2011 the Commission agreed that Southern right whales off South America should be the subject of IWC Conservation Management Plans. Two draft plans were available during the Scientific Committee meeting, one for Southwest Atlantic southern right whales (IWC/64/CC7 Rev1) and one for South-eastern Pacific southern right whales (IWC/64/CC9). The Scientific Committee examined these draft CMPs for their scientific content and found them to be in accord with the results and recommendations from the Commission's Workshop on the Status of Southern Right Whales (SC/64/Rep3) and the southern right whale die-off.

WESTERN NORTH PACIFIC GRAY WHALES

The Scientific Committee noted that the CMP for Western North Pacific gray whales was already in action and that one of the plan's recommendations was for satellite tagging. Several whales had been tagged and the CMP was being updated using data from these whales (see Item 6.4.1).

9.2 Report of the Conservation Committee

9.2.1 Report from the Conservation Committee's Standing Working Group on CMPs

The report of the SWG on CMPs (IWC/64/CC12 Rev)included a number of recommendations submitted to IWC/63. The Commission had limited time to fully consider the CMP documents in 2011 so they are submitted again to IWC/64, noting that two of the recommendations have already occurred:

- that the CMP guidelines, templates and funding principles presented in IWC/63/CC5 be adopted;
- that these documents be placed on the IWC website for use by members wishing to undertake a CMP;
- that the Small Advisory Group on CMPs be reconstituted as a Standing Working Group on CMPs (has occurred);
- that the terms of reference for the CMP Working Group, contained in IWC/63/CC5, be adopted (has occurred);
- that the Scientific Committee be invited to undertake an analysis of priority candidates for future CMPs; and
- that the Conservation Committee be tasked with undertaking an inventory of cetacean conservation measures currently in place or underway in jurisdictions, on a regional basis.

In addition the SWG on CMPs recommended that the Conservation Committee endorse the following recommendations for cetacean conservation measures in the Pacific Islands Region, with a focus on Oceania humpback whales, for consideration by the Commission:

- that the Commission note the Review of Measures for Marine Mammal Conservation, Protection and Management in the Pacific Islands Region in 2007 by IFAW and SPREP;
- that the Commission acknowledge the significant cetacean conservation measures currently in place to protect cetaceans in the Pacific Islands region, as identified in this inventory;
- that the Commission recognise the leadership of SPREP in advancing cetacean conservation in the Pacific Islands region, including through implementation of its regional Whale and Dolphin Action Plan and its partnership with CMS on the CMS Pacific Cetaceans MoU, and the important role of organisations such as South Pacific Whale Research Consortium;
- that the Secretariat write to SPREP advising it of the work of the Standing Working Group on CMPs and inviting SPREP to participate as an observer to the Working Group;

- subject to the views of SPREP and the Pacific Island Contracting Parties, if this inventory is considered a useful model it is proposed that the Chair of the Working Group contact SPREP with a view to exploring options to further refine the inventory;
- that similar regional inventories be developed for regions around the globe as part of the work of the Conservation Committee; and
- that regional inventories of cetacean conservation measures should be updated periodically (every 5-10 years or as appropriate).

The Conservation Committee thanked the SWG for its work and endorsed all of the above the recommendations including the request for the Scientific Committee to provide a priority list and the invitation to SPREP to participate as an observer. The Secretariat confirmed that they could implement the request to SPREP.

The USA expressed continued support for conservation management plans as they reaffirm the conservation objective of the Convention and improve the Commission's conservation work.

9.2.2 Report of Conservation Committee discussions and recommendations

Last year the IWC agreed to nominate the South American southern right whale population for a CMP (see IWC/63/CC4). Workshops held in Buenos Aires, Argentina in September 2011 recommended that the plan be separated into two, one for the Southwest Atlantic Southern right whale and one for the Southeast Pacific right whales.

SOUTHWEST ATLANTIC SOUTHERN RIGHT WHALES

Argentina introduced the CMP for the Southwest Atlantic Southern right whale (see IWC/63/CC7Rev1). A workshop was held in Buenos Aires from 19–20 September 2011 to begin the development of the CMP at which three documents were considered: (i) the Report of the Southern Right Whale Die-Off Workshop, (ii) a Draft Proposal for an Action Plan for the Recovery of Eastern South Pacific Southern Right Whales in Chile (IWC/63/CC21Rev) and (iii) the conclusions and outcomes of the IWC Southern Right Whale Assessment workshop held in Buenos Aires from 13-16 September 2011. The overall objective of the CMP was to protect the southern right whale habitat and minimise anthropogenic threats to maximise the likelihood that southern right whales will recover to healthy levels and recolonise their historical range.

The following nine high priority actions were identified: (i) implementation of the CMP; (ii) development of a strategy to increase public awareness and build capacity in range states; (iii) determination of movements, migration routes and location of feeding ground(s) through satellite telemetry; (iv) development of a GIS database on information on human activities that might have an adverse impact on whales; (v) ensuring long-term monitoring of abundance, trends and biological parameters through photo-identification and biopsy sampling; (vi) enhancing the existing stranding networks including the capacity for undertaking post-mortems; (vii) development of a regional entanglement response strategy; (viii) development and implementation of a strategy to minimise kelp gull harassment; and (ix) establishment of an expert advisory panel. The most critical and urgent action was the implementation of the CMP. Funding must be found for this action as soon as possible to appoint a coordinator and set up the steering group to ensure that the CMP moves ahead in a timely fashion. The estimated cost would be about £50,000, to include funding of the first meeting of the interim steering committee and the salary of a coordinator.

The Conservation Committee endorsed the CMP for the Southwest Atlantic Southern right whale and recommended it to the Commission, noting the need for funding.

SOUTHEAST PACIFIC SOUTHERN RIGHT WHALES

The Southeast population of Pacific right whales is critically endangered and is estimated to include less than 50 mature individuals. The CMP is based on Chile's national plan of action submitted last year (IWC/63/CC21Rev), so some actions of the plan were already operational. The objective is to take steps which will allow the species to withstand both environmental and anthropogenic impacts and ensure its long term survival. Lack of information is the biggest limitation to protection so the short term objectives focus on: (1) compiling a baseline of information to include in particular population size and area of concentration, breeding and feeding grounds, stock structure, etc., (2) conducting a detailed assessment of potential impacts in identified areas of concentration, and (3) developing specific mitigations despite the shortage of information.

The CMP requires the establishment of a co-ordinator and Steering Committee. The Conservation Committee thanked Chile for its excellent work, endorsed the CMP for the Southeast Pacific right whale, and recommended it to the Commission noting the need for funding for the co-ordinator role.

9.3 Commission discussions and action arising

Chile commended the Conservation Committee's good work in developing CMPs for the different populations.

The Commission noted the reports of the Scientific and Conservation Committees on this agenda item and endorsed any recommendations. Discussion on the funding of the two CMPs for southern right whales was held under Item 25.3.4.

10. WHALEWATCHING

In 2011 the Commission endorsed the IWC Five Year Strategic Plan for Whalewatching pending review by the Scientific Committee of the Plan's research and assessment objectives prior to the Commission's meeting in 2012. Also in 2011 the Commission reviewed and updated the terms of reference for the Conservation Committee's Standing Working Group on Whalewatching (SWG-WW) and expanded its membership to include two members of the Scientific Committee.

10.1 Report of the Scientific Committee

The Scientific Committee discussed aspects of whalewatching in response to Commission Resolution 1994-14, and its full report on Whalewatching is provided at IWC/64/Rep1, Annex M. A brief summary is provided below.

ASSESSMENT OF THE IMPACTS OF WHALEWATCHING ON CETACEANS

The Scientific Committee received reports of data collected during whalewatching trips and also received reports of the development of statistical models to help examine the potential effects of whalewatching. The Committee welcomed both of these types of study and suggested that collaboration take place between these two research groups to test the models.

The Scientific Committee reviewed whalewatching off Central America and was pleased to learn that many countries held workshops to train and certify operators in best practices. However this was not the case for all countries and the Committee recommended that those not currently doing so could establish training workshops.

REPORTS FROM INTERSESSIONAL WORKING GROUPS

The Scientific Committee has developed a Large Scale Whalewatching Experiment (LaWE) to understand the mechanisms and large scale effects of whalewatching on whale populations. To start these investigations the Committee received an initial analysis using information from 10 different whalewatching operations around the world. This showed that some whales and dolphins change their resting behaviour and swimming paths though smaller sized species were more likely to be affected by whalewatching vessels.

The Committee reported that it is developing a database to record details of worldwide whalewatching operations. In addition, it reported that it had received a questionnaire that had been developed and field tested for operators that conducted swim with whale operations. The questionnaire would be presented more widely over the coming intersessional period and the Committee expected to receive results within two years.

OTHER ISSUES

The Committee discussed the scientific aspects of the Commission's five year strategic plan for whalewatching and made detailed recommendations. It had commenced an intersessional correspondence group to help develop the guiding principles under Action 1.1 of the strategic plan. In addition the Committee reported that it would complete Action 1.2 during the intersessional period and report on this at the next meeting.

The Committee received the report of the regional marine mammal workshop held in Panama in October 2011. This brought together marine mammal tour operators and government regulators from across the Caribbean region.

The Scientific Committee recorded its concern at unregulated whalewatching on the small Arabian Sea humpback whale population which is also affected by ship strikes. The Committee recommended that operators receive training in best practices for whalewatching operations and to aid the interpretation and implementation of revised whalewatching guidelines. A funding proposal to support this had been presented to the Budgetary Sub-committee.

10.2 Report of the Conservation Committee

10.2.1 Report of the Standing Working Group on Whalewatching

The Chair of the Standing Working Group on Whalewatching (SWG-WW) reported on the group's activities over the past year which included examination of each section of the 5-Year Strategic Plan (see IWC/64/CC6 Annex B). The SWG-WW developed recommendations on how to move forward on actions that were outside the focus of the Scientific Committee review and on which actions should be implemented through the web-based living handbook. The SWG-WW also decided that it would greatly benefit from industry input and recommended the inclusion of two industry representatives on the SWG-WW as *ex officio* participants. Nominees for the first two representatives were recommended to come from Australia and Mexico with potential funding support from the IWC.

The SWG-WW Chair outlined the future work of the SWG-WW and expressed hope that the Plan will be finalised at IWC/64. To allow for a possible Commission decision to move to biennial meetings at IWC/64, the SWG-WW proposed a plan of work for the potential intersessional period of 2012-14. The following four recommendations of the SWG-WW were highlighted.

(1) The addition and potential funding of two *ex officio* industry representatives to the SWG-WW.
(2) The two requested documents from the Secretariat to facilitate implementation of the Plan.
(3) The SWG-WW work plan for the proposed intersessional period of 2012-2014.
(4) Adoption, after discussion, of any accepted changes to the 5-Year Strategic Plan suggested by the Scientific Committee.

The SWG-WW Chair also presented document IWC/64/CC24, which highlighted the changes to the Action Plan 2011-2016 based on the Scientific Committee recommendations.

The Conservation Committee thanked the SWG-WW for the good progress that has taken place on the co-ordination of work on whalewatching during the intersessional period and thanked Ryan Wulff for his leadership of this important group.

10.2.2 Report of the Conservation Committee discussions

Many delegates expressed support for the work of the SWG-WW and the comments of the individual delegates are recorded in the Conservation Committee's report[23]. The Conservation Committee endorsed the recommendations of the SWG on whalewatching and endorsed the 5-year Strategic Action Plan.

10.3 Commission discussions and action arising

The USA reported on its existing and on-going research efforts to inform the management of all whalewatching activities, including the use of regional voluntary viewing guidelines and regulations. While the majority of whalewatching in the USA was managed through voluntary guidelines, whalewatching was managed under regulations for endangered humpback wales in Alaska and Hawaii, endangered North Atlantic right whales and endangered southern resident killer whales. The USA worked with whalewatching operators domestically and internationally to support the development of responsible practices and the provision of benefits to local communities. Most notably, the USA and its partners in the NGO community sponsored the Dolphin Smart and Whalesense programmes which were voluntary recognition and education programmes to encourage responsible viewing by whalewatching businesses. Businesses that participate were provided with outreach material for their customers and the opportunity to advertise their participation in marketing campaigns. The USA noted the work of the small working group on whalewatching and fully endorsed the adoption of the 5-year strategic plan.

India recorded its support for whalewatching and ecotourism so long as it is undertaken safely for both whales and the whalewatchers. During whalewatching all safeguards for environmental protection should be taken and protocols followed to specifically address the impact on the time and space of the targeted species. Whalewatching could generate alternative sustainable livelihoods for aboriginal communities engaged in whaling operations and India supported efforts to build sustainable whalewatching industries.

Argentina supported the work of the SWG-WW and the recommendations of the Conservation Committee. It noted that whalewatching had taken place in Argentina since the 1970s and that recently whalewatching vessels had been fitted with satellite vessel monitoring systems so as to enable their positions and tracks to be recorded. This year the whalewatching season had been affected by volcanic activity in the Andes Mountains which had reduced visitor numbers by 16% compared to the 2010 season.

Panama highlighted the importance of whalewatching as a wonderful non-lethal use of whale resources which helped the development of coastal communities. It explained that part of its reason for hosting the Commission's 64th Annual Meeting was to promote Panama as a world class destination for whalewatching. It was pleased to see the adoption of the 5-year strategic plan as a tool for continuing work on best practices under the auspices of the IWC. Panama noted the recommendations made by both the Scientific and Conservation Committees regarding some of the whalewatching activities taking place, and thanked the Government of Argentina who had worked closely with authorities, academia and civil society to train operators in whalewatching practices on both the Pacific and Caribbean coasts. It also thanked participants to the marine mammal watching workshop held in Panama in October 2011 and indicated it would continue to support and promote similar activities in the future.

Cyprus, on behalf of the European member states party to the IWC thanked both the Scientific Committee and the Conservation Committee for their work. It noted that whalewatching provides incomes and benefits for many coastal

[23] IWC/64/Rep 5 Section 6.3

communities all over the world. When managed wisely, whalewatching was a well-respected, non-lethal and sustainable use of cetacean resources and a driving force for the development of ecotourism. Cyprus commented that in addition to the wide ranging socioeconomic benefits which arise from whalewatching that it can also make an important contribution to scientific research. There are now several examples where whalewatching boats have served as platforms for study of cetacean populations and in the past few years the increased work on whalewatching has led to an increased dialogue between the Scientific and Conservation Committees. The expertise provided by the Scientific Committee could be further developed to produce science based management options for whalewatching.

The Dominican Republic commended the Conservation Committee for its work and emphasised that whalewatching is a significant industry within its country. It stated that it was beginning to engage in dialogue with other Caribbean countries to set up sister sanctuary arrangements and it encouraged all countries present to continue conducting studies on whalewatching in the waters of the Dominican Republic. It noted that financial resources from the USA, France and the Dominican Republic were being used to support such studies. Ecuador also commended the work of the Conservation Committee and reiterated the importance of whalewatching in supporting the livelihoods of developing coastal communities.

Colombia reiterated its commitment to the IWC's agenda for the conservation of healthy whale populations as an integral part of the marine ecosystem and supported the work of the Conservation Committee. Each year Colombia's Pacific coast shelters female humpback whales who raise calves, and responsible whalewatching based on established protocols is used to generate income.

Chile commended the work of the Conservation Committee and stated that whalewatching was an important non-lethal use of whales. It expressed gratitude for the recommendations of the Scientific Committee which it was currently implementing.

Korea introduced its whalewatching pilot project which was operational in the Ulsan area. The project had only been established for three years and it was premature to assess socio-economic benefits to date, but Korea continued to promote whalewatching tourism.

Augusto Gomez, President of the Whalewatching Boat Owner's Association of Samana Bay in the Dominican Republic emphasised the importance of whalewatching in the Dominican Republic and wider Caribbean where 23 countries currently carried out whalewatching operations. Each year in the Dominican Republic around 40,000 tourists take part in whalewatching which provided revenue of US$2.3million over a season of 72 days duration. This rapidly growing industry also provided US$9million in indirect benefits. He noted that whales are a vitally important resource which supported a fleet of 43 boats owned by up to eight companies in Samana Bay, most of whom are native Dominicans and former fishermen. He commented that the whales face various threats including climate change, pollution, ship strikes, entanglement in coastal areas and sound pollution as well as whale hunting. The whales are a shared resource of the wider Caribbean, and the Whalewatching Boat Owner's Association called on the representatives of all nations present to prevent the co-existence of contrary activities on the same Caribbean populations of whales. He reminded those nations of the value of whales when alive and the financial gain which whalewatching brought to the coastal communities of the Caribbean.

The Commission noted the reports of the Scientific and Conservation Committees on whalewatching and endorsed any recommendations.

11. WHALE KILLING METHODS AND ASSOCIATED WELFARE ISSUES

The working group on Whale Killing Methods and Associated Welfare Issues met in Panama on 25 June 2012. Michael Stachowitsch (Austria) chaired the meeting which was attended by 24 Contracting Governments. A summary of the Working Group's discussions is included below and the full report is available at Annex G.

11.1 Data provided on whales killed

REPORT OF THE WORKING GROUP

The Working Group received reports from the USA on its bowhead hunt (IWC/64/WKM&AWI 8 and 10), from Denmark on their Greenlandic hunts (IWC/64/WKM&AWI 7), from the Russian Federation on its gray whale hunt (IWC/64/WKM&AWI 6) and from Norway on its minke whale hunt (IWC/64/WKM&AWI 9). A document from New Zealand (IWC/64/WKM&AWI 4) was also reviewed on euthanasia of stranded cetaceans deemed beyond hope of rescue. Three countries stated that they provided whale killing data to NAMMCO as they considered it to be a more suitable venue.

COMMISSION DISCUSSIONS AND ACTION ARISING

Australia supported by Mexico noted that a major mandate of the Working Group was to provide a mechanism by which improvements and efficiencies can be achieved in hunting techniques such that the welfare of the hunted whales can be improved. Such improvements rely on open exchange of information and collaboration between members who share and promulgate improved techniques. Australia noted that the Alaskan Eskimo Whaling Commission presented data that demonstrated improvements in hunting efficiency and it welcomed these data as did many other members. However Australia highlighted its concern at the highly variable pattern of reporting of whale killing data by some other members. It noted that three of these members informed the working group that they provide their data to a different organisation. Australia respected the rights of countries to report their data to multiple organisations but it did not view this as an alternative to the IWC. Australia believed that the reporting of comprehensive whale killing data is a core responsibility of any member involved in hunting whales. To not do so to the IWC was an abrogation of that responsibility. The lack of these data inhibited the Commission's ability to deal with important welfare issues that are in the interest of all members to address. Australia strongly urged all members to submit their data and facilitate the improved ability of the Working Group to achieve its mandated task. Argentina called on all countries to submit data so as to allow the Commission to work at an optimal level.

Japan recalled that in the past it had voluntarily presented reports on killing methods and related welfare considerations to the IWC for the purpose of improvement of killing methods, reduction of time to death and also the safety of the workers. These reports had allowed a reduction of time to death and an improvement in the efficiency of the hunt. However Japan stated that the data and the information that it provided was not always used for the purposes for which it was intended and instead it had been used by anti-whaling organisations. Therefore Japan would reserve the right to present data on killing methods to the IWC. Japan would present data collected in the North Pacific to NAMMCO and would continue its constructive efforts for the improvements of whale killing and for the enhanced welfare of whales.

Norway stated that it had submitted more than 25 reports on whale killing statistics to the IWC since 1983. In addition it had participated in IWC workshops from 1980 and to 1992, 1995, 1999, 2003 and 2006 and in total submitted data for more than 5500 minke whales. In this way Norway had discussed the animal welfare problems associated with whaling at length and had worked to improve both the Norwegian hunt and hunts in other countries. However it had found that the discussions in IWC were not very productive and on occasion had been counterproductive. Norway had therefore decided to move its focus over to a body where discussions could be based on animal welfare and not the politics associated with whaling. Norway said it would continue to discuss these matters in NAMMCO because of its philosophy that whale hunting is a legal activity and that it would continue to help the hunters to improve their methods and through this, improve animal welfare in the hunt.

11.2 Improving the humaneness of whaling operations

11.2.1 National Reports

REPORT OF THE WORKING GROUP

USA

The Chairman of the Alaska Eskimo Whaling Commission commented on the efficiency of the 2011 hunt which was 75%. The on-going weapons and training improvements had continued and the use and success of the new penthrite grenade was increasing.

NORWAY

Norway reported on the long history of its research and the improvements to whale killing methods which it had instigated. It reported that 80% of the animals are rendered instantaneously and irreversibly unconscious as opposed to only 17% in the 1980s. Norway also played a major role in assisting other countries with training and improved technology.

COMMISSION DISCUSSIONS AND ACTION ARISING

St. Vincent and The Grenadines noted that its whalers currently use darting guns and that there had been a general improvement in times to death from between 30-40 minutes to about 10-20 minutes except in extenuating circumstances such as bad weather. St. Vincent and The Grenadines remained committed to the improvement of the humaneness of its hunt and was investigating the possibility of upgrading its darting guns to use the more effective penthrite explosive. It was holding discussions with the USA and other countries on this matter and would report its progress to the Commission and appropriate Committees in due course.

The Russian Federation highlighted that it voluntarily submitted the data to the Working Group which demonstrated that the time to death for gray whales had declined by 30% recently and the amount of shots per animal had also declined. This year the local Government of Chukotka had supported the efforts of the local population to improve the humaneness of the hunt through the purchase of 45 darting guns which were distributed to coastal villages with the help of the Union of Marine Mammal hunters. The Russian Federation expressed gratitude to Dr Egil Øen for his support in the training of the marine mammal hunters, to the Alaskan Eskimo Whaling Commission for their constant support, to the Coastal Communities of Japan who provided technical support and to the Government of the Netherlands which helped with organising the workshop for training the Marine Mammal hunters. The Russian Federation confirmed that it would continue to voluntarily provide information to the IWC Working Group on the welfare of its hunt.

11.3 Welfare Issues associated with the entanglement of large whales

11.3.1 Presentation of the report of the second IWC Workshop on Welfare Issues Associated with the Entanglement of Large Whales

REPORT OF THE WORKING GROUP

The Working Group received the report of the second IWC Workshop on Welfare Issues Associated with the Entanglement of Large Whales (IWC/64/WKM&AWI Rep 1). This workshop built on the progress made at the first IWC workshop in 2010 and also reviewed the findings of a workshop held in 2011 to develop recommendations for stranded whale euthanasia methods. A major outcome of the workshop was the development of a set of Principles and Guidelines for Entanglement Response which were summarised in five points:

(1) first comes human safety;
(2) second animal welfare;
(3) the entanglement response can contribute to the conservation of large whale populations as well as animal welfare issues;
(4) data collection to assist with identifying key fisheries and whale populations to better describe the problem and assist with mitigation and prevention should be an integrated part of the entanglement response;
(5) awareness at all levels to improve reporting and appropriate measures to address the mentioned issues.

The Workshop agreed on an outline for capacity building and training and requested that the Commission endorse the global network of Entanglement response operations, the guidelines and principles for disentanglement response and the recommended approach to capacity building and training.

With regard to capacity building the Workshop requested the Commission to consider the following approach:

(1) to establish a dynamic entanglement response section on the IWC Website;
(2) to consider establishing an international entanglement database;
(3) to facilitate data exchange;
(4) to promote establishment of national entanglement response networks;
(5) to provide advice to member governments;
(6) to develop a proposal for an international workshop on entanglement prevention;
(7) to continue to promote an IWC-managed fund for the entanglement response.

The Working Group strongly endorsed the conclusions and recommendations contained in the Workshop's report and commended them to the Commission.

COMMISSION DISCUSSIONS AND ACTION ARISING

Cyprus spoke on behalf of the EU Member States party to the IWC and stated that the IWC is the global body responsible for the conservation and management of the world's whales. For over 60 years the Commission had played a role in addressing animal welfare issues. Cyprus believed that integrating animal welfare into the full spectrum of the IWC's work would contribute to moving away from a debate that centred on whaling and would allow consideration of animal welfare issues in much broader terms. Support for the recommendations of the report would allow the IWC to move towards a more scientific, integrated and objective approach to decision making in the field of animal welfare and ethical concerns.

The USA supported by Mexico endorsed all of the recommendations contained within the report of the second Workshop on Welfare Issues Associated with the Entanglement of Large Whales. It fully supported the principles and guidelines contained within the report as well as the capacity building curriculum developed at the Workshop.

The Republic of Korea stated that euthanasia was not feasible where bycaught whales were found dead in nets. However, under Article 10 of its new Directive on the Conservation and Management of Cetacean Resources which was implemented on 3 January 2011 any person who had accidentally caught a cetacean must report it to the local police station and take the necessary measures to rescue the cetacean if it is found alive.

11.3.2 Report of the Technical Expert's secondment to the Secretariat

REPORT OF THE WORKING GROUP

The Working Group received a report of David Mattila's secondment to the Secretariat and his work to support the capacity building programme for entanglement response. This included conducting seminars in Argentina and Brazil on the theory and practice of entanglement response and mitigation.

COMMISSION DISCUSSIONS AND ACTION ARISING

Mexico thanked Mr Mattila for his work and the USA noted the success of the seminars held in Argentina and Brazil in 2012 and announced a further voluntary donation of $12,000 to facilitate additional work on entanglement response and to support training of apprentices from Argentina and Brazil in advanced water entanglement response. Brazil and Argentina thanked the USA for its financial contribution and the IWC for the training workshops held in 2012. Argentina noted that entanglement response was an issue on which all parties could work together.

11.3.3 Proposal to address human impacts on cetaceans in the wider Caribbean

REPORT OF THE WORKING GROUP

The Working Group received a proposal sponsored by the Dominican Republic, France, Mexico, Panama and the USA to help address indirect human impacts on marine mammals in the wider Caribbean region including entanglements and ship strikes. The document proposed that the Secretariats of the IWC and the UNEP Caribbean Environment Programme's (CEP) Specially Protected Areas and Wildlife (SPAW) Action Plan should work together to convene workshops on:

- Large whale entanglement response, with one workshop planned for 2012 and a second in 2013 for Spanish and French speakers respectively, and
- An interdisciplinary ship strike workshop to be held in 2013[24].

The Working Group welcomed and supported this collaborative initiative and commended it to the Commission.

COMMISSION DISCUSSIONS AND ACTION ARISING

Mexico reiterated its interest in holding the workshop on disentanglement entanglement response and ship strike reduction.

11.4 Whale Welfare

11.4.1 Intersessional work by the United Kingdom on welfare and ethics

REPORT OF THE WORKING GROUP

The Working Group received a report from the United Kingdom on the intersessional workshop which it convened in March 2012 in London (see IWC/64/WKM&AWI3). There was considerable discussion within the Working Group on how the IWC might take the issues forwards, following which the Working Group requested the Commission's approval that it forms an *ad-hoc* intersessional working group to:

(1) review its Terms of Reference and existing Action Plan; and

(2) identify and agree upon important issues or themes to progress the promotion of good animal welfare and agree a timetable of regular future technical workshops on these issues.

In addition the Working Group recommended the development of plans for an expert workshop on the euthanasia of large whales (both stranded animals and those entangled whales for which euthanasia appears to be the only option in accordance with the decision tree developed at the Maui workshop). This workshop could take advantage of the extensive previous discussions at IWC expert workshops relating to the criteria for determining unconsciousness and death in whales. The technical workshops would report back to the relevant working groups, recognising the success of previous IWC workshops on specific issues incorporating invited external experts.

Finally, the Working Group recommended that the Secretariat be asked to (a) develop a database of external contacts with expertise in animal welfare science pertinent to work being undertaken by the Commission; and (b) recommend to the Commission opportunities for constructive co-operation with other relevant animal welfare bodies.

COMMISSION DISCUSSIONS AND ACTION ARISING

Argentina, Brazil, India and the USA thanked the UK for holding the intersessional workshop and supported its recommendations. The USA congratulated the Head of Science on his presentation to the workshop and requested it be made available to Commissioners via the website. Colombia stated that it was important to continue working on euthanasia and response to entanglements and suggested that the Secretariat could develop a database of contact information for specialists within and outside the IWC who could work jointly to help manage such cases. Colombia, Mexico and the USA insisted that animal welfare should not be limited to whale hunting and should extend to all aspects addressed by the IWC including responsible whalewatching. Colombia supported the strengthening of financial mechanisms for activities related to animal welfare. Mexico indicated that it was developing new regulations to govern

[24] See also Item 8.2.2 for the Conservation Committee's discussion of the proposed ship strike workshop.

whalewatching and India recognised the need to implement measures to circumvent the under-reporting of entangled whales. The USA recorded its desire to participate in the forthcoming euthanasia workshop as well as in future work related to the Working Group's recommendations.

The United Kingdom thanked the countries who had participated in the positive discussions surrounding welfare issues and indicated it would co-ordinate the intersessional work and convene the workshop on euthanasia of stranded whales next year. It invited all Contracting Parties to participate in the work and said it would report back to IWC/65 in 2014.

Claire Bass of The World Society for the Protection of Animals (WSPA) congratulated the United Kingdom on its constructive leadership on the animal welfare issue and welcomed the recognition in the workshop report that numerous human activities in the marine environment can have direct and indirect adverse impacts on whale welfare. WSPA welcomed the recognition by Cyprus, Colombia, USA and others that animal welfare is relevant and important to a wide range of issues discussed within the IWC, including but not limited to ship strikes, whale watching, entanglements, and scientific research, as well as whaling. Furthermore, it was encouraged that the United Kingdom workshop recommendations had been well-received by the Commission and that there was an opportunity for constructive and collaborative work on animal welfare to take place. Given the relevance and importance of animal welfare across the spectrum of the IWC's work WSPA believed that it would be beneficial for the working group to begin to draft guiding principles on animal welfare. It suggested that such principles be of a general nature, not specific to particular activities, and that they could be used by the Commission and all of its working bodies to help ensure clarity and consistency of approach to the promotion of good animal welfare across all areas of the IWC's work. Noting the likely costs in realising the recommendations – for example, the possible need for an intersessional meeting - WSPA wished to donate £3,000 towards the costs of these activities.

The Commission noted the report of the Working Group on Whale Killing Methods and Associated Welfare Issues and endorsed its recommendations.

12. SOCIO-ECONOMIC IMPLICATIONS AND SMALL TYPE WHALING

12.1 Commission discussions and action arising

Japan introduced IWC/64/9 which was a proposal to amend the Schedule of the ICRW so as to establish a minke whale catch limit for Japanese small-type whaling vessels. Japan noted that previous IWC Resolutions had recognised the importance of the socio-economic, cultural and traditional needs arising from coastal and small type whaling especially given the impact of the moratorium. It highlighted the importance of allowing coastal communities to use their resources sustainably and noted that the need to alleviate the difficulties being faced by those communities had previously been agreed to some extent. However Japan's requests on this matter had always been rejected. From 1986 to 1995 Japan had submitted 37 anthropological, social and economic research papers by international experts in the field of the history, culture and tradition of coastal whaling. The coastal whaling culture shares many aspects in common with the aboriginal subsistence whaling which is approved by the IWC through its catch limits.

Japan explained that its proposal would allow the traditional regional culture of landing, processing and consumption of whales to be restored. Traditional ceremonies and rituals would also be restored. Catch limits would be allocated to the regional communities. Japan's proposal was not to request a lifting of the moratorium but instead to ask for an exemption to the moratorium, as in the case of Aboriginal Subsistence Whaling.

Japan confirmed that document IWC/64/9 did not indicate a specific catch quota because it was willing to negotiate on this issue with Contracting Governments. It stated that in order to secure an appropriate level of whaling activity it was intending to introduce monitoring and surveillance measures which included acceptance of an international inspection and monitoring protocol. This would include a vessel monitoring system and also DNA registration of the whale meat obtained. Japan said that to ensure transparency, reliability and accountability it was willing to accept IWC Contracting Governments forming a monitoring committee.

Japan commented that it had shown through document SC/61/O15 that the catch of minke whales by this proposal would be negligible in terms of the long term sustainability of the stock. In addition document SC/62/NPM31 showed that the J stock could not be considered as a protection stock under the terms of the New Management Procedure.

Japan proposed that the duration of the catch limits should be either five or six years in order to accommodate the proposed cycle of IWC biennial meetings. It re-emphasised that: (1) the landing, processing, allocation and consumption of whales are traditional practices and that the whaling would be permitted in order to restore those community based practices; (2) the consumption of the meat and products would be limited to domestic consumption and the landing and processing would take place within the traditional regions and communities; and (3) the catches of minke whales from the Pacific would be negligible in terms of the long term sustainability of the stock and the J-stock minke bycatch which may occur in small numbers is also negligible in terms of the long term sustainability.

Japan repeated that its proposal is not to lift the moratorium but rather to request an exemption to it under the control of the IWC. Monitoring and surveillance measures coupled with an oversight committee would ensure that excessive catching would not take place and that the whaling activity would be transparent. It hoped that all Contracting Governments would support the proposal and that it could be adopted by consensus.

The President of the Small Type Whaling Association said that 25 years have passed since the commercial whaling moratorium came into effect in the coastal waters of Japan. The whaling communities of Abashiri, Ayukawa, Wadaura and Taiji previously engaged in small type whaling as an integral part of their history. Small type whaling operations are limited in scale and Japanese research has shown that coastal minke whale resources are healthy and abundant. Historical evidence shows that ancestral communities had started utilising beached whales thousands of years ago in a move which created the beginning of the Japanese whaling industry. Whale meat and blubber are traditional food and whale dishes are an indispensable part of weddings, funerals and the New Year season. The meat and blubber of the first whale caught each season is distributed to the local people and such traditional practises have been passed down from generation to generation. The Small Type Whaling Association believed that its communities have survived today thanks to the whaling activities. The IWC's Convention stipulates that its purpose is to ensure the sustainable use of whales and for the orderly development of the whaling industry. Unfortunately IWC's commercial whaling moratorium had caused great distress to the Japanese coastal communities for a quarter of a century. The Small Type Whaling Association continued to hope that the IWC will return to the spirit and letter of its charter and establish a minke whale quota for its communities before it rendered itself entirely irrelevant to the issue of whaling management.

Korea expressed its support for the Japanese proposal because it would allow the maintenance of their long coastal whaling tradition and the associated cultural and nutritional needs for whale meat as a traditional dish. Korea commented that Japan's situation was similar to its own and referred to the presentation it made of whaling history around Ulsan at IWC/61 in 2009. It commented that dietary cultures which developed based upon the historical and geographical environment were not easy to change. Korea expressed concern about the absence of a practical review of Article 10(e) of the Schedule which requires the Commission to undertake a comprehensive assessment of the effects of the moratorium and consider modifications.

Iceland said that the long history of the Japanese proposal to establish a catch limits for small type coastal whaling showed that the IWC is still having problems functioning in a regular and sensible way. Iceland associated with Japan and Korea and stated that sustainability is the main issue. As long as the hunting is sustainable, Iceland would support the proposal.

St Vincent and The Grenadines identified with the plight of the coastal communities of Japan and highlighted the need to understand the cultures of peoples who lived in differing conditions and who depended upon marine resources for their subsistence and survival. It noted the inherent desire of all independent peoples to retain their traditions and culture in a sustainable manner and supported the proposal made on behalf of the coastal peoples of Japan.

The Republic of Guinea commented that it was in favour of the protection and conservation of marine resources and that whaling was banned under its laws governing fishing. However, the IWC's Scientific Committee was able to assess stocks and could define what could be removed without harm to existing stocks and that it was necessary to consider the traditions relating to people's lives. If there is no threat to the stock it could not see why the IWC would adopt a philosophy which continuously rejected requests to take whales and jeopardised the local populations. In this regard it requested that such issues be dealt with in the light of scientific advice.

Australia stated that the proposal by Japan sought permission from the IWC to carry out a commercial whaling venture. This was confirmed by the request to include this quota under Paragraph 10 of the Schedule as an exception to the moratorium on commercial whaling. Australia confirmed it was resolutely opposed to all forms of commercial whaling and that it strongly supported the global moratorium on commercial whaling that was put in place by the IWC. Australia could not support a proposal that would legitimise commercial whaling and completely undermine the moratorium in the process. Australia believed that the proposed schedule amendment made a mockery of the scientific advice given the concerns over the viability of minke populations in the north west Pacific arising from the impacts of existing whaling under JARPN II, the increased accidental catch, entanglements and other emerging threats to cetaceans including ship strikes, climate change, marine pollution and the risks the proposal represents to the J-stock for which the conservation status remains unknown. Australia stated the total mortality of whales had continued to escalate over the past decade. The Commission has recognised concerns over the conservation status of J-stock minke whales and has listed this population as a Protection Stock under Schedule Paragraph 10(c) which clearly stipulates that there shall be no commercial whaling on protection stocks. Australia emphasised that it could not support a proposal that would legitimise commercial whaling and it expressed deep concerns over the disregard of science through the proposed

Schedule amendment. Australia said that efforts must be made to recover this whale population and that the range states concerned should be putting their efforts into a conservation management plan. Monaco stated its strong opposition to commercial whaling and supported the statement by Australia.

The USA associated itself with the comments of Australia and highlighted its concern regarding the large removals of minke whales in the waters off Japan and Korea. The USA supported the Scientific Committee completing its review of these stocks as a matter of the highest priority and noted that this was expected to be achieved in 2013. The USA confirmed that it supported the moratorium on commercial whaling and could not support the Japanese proposal.

Denmark enquired if the figure for the minke whale catch limit would also cover the scientific whaling or whether the requested quota would be additional to whales taken under special permit.

The Russian Federation commented that Japan started to use whales 9000 years ago with large whale hunts dating back 2000 years. Only Korea had a similarly long traditional history and indeed the first international agreement on whales was signed between Japan and Korea in the 19th Century. The four coastal villages highlighted by Japan had the longest history of whaling and it is important to protect not only biodiversity but also cultural traditions. Resolution 2004-2 reaffirmed the Commission's commitment to work to alleviate the continued difficulties caused by the cessation of minke whaling in Japanese coastal towns and the Russian Federation suggested that the decision on the proposal contained in IWC/64/9 should be taken at the current meeting rather than waiting a further year for the outcome of the Scientific Committee's analysis of the North Pacific minke whale stocks.

New Zealand commented that this was a difficult issue and that the initial impact of the moratorium on Japanese communities should not be underestimated. However, the moratorium came into effect over 25 years ago. New Zealand expressed its sympathy to the plight of the communities following the great east Japan earthquake and tsunami and recalled that it was one of the first countries to send a search and rescue team after that event. However the proposal in IWC/64/9 asked for an exception to the moratorium on commercial whaling which could not be accepted by the IWC. Furthermore the status of the stocks being fished, including by members of these communities under Japan's so called research programs, is highly questionable and accordingly New Zealand stated it could not support the proposal.

Mexico stated it could not support the proposal because it wished to defend the moratorium on commercial whaling and because the Scientific Committee's report indicated a complex population structure for North Pacific minke whales and an associated risk to the J-stock. It noted that the boats involved in small type whaling already took part in scientific whaling which has authorised hundreds of whales to be hunted. Mexico recalled that researchers from universities in Japan have recommended that the communities are not suffering any difficulties when they are unable to hunt whales and so the quotas being requested were unnecessary.

Cyprus spoke on behalf of the EU member states party to the IWC to reiterate its position to proposals for new types of whaling. It believed that any new category of whaling operation would essentially be commercial whaling and accordingly would undermine the current moratorium. Cyprus also raised serious doubts about the potential impact on whale populations and the lack of defined and genuine subsistence needs of coastal communities.

Ecuador expressed its concern over the proposal described by IWC/64/9 to side step the work of the Commission and especially the moratorium. It said that proposal could not be justified based on cultural factors but instead reflected a clear interest in commercial whaling. Ecuador felt that the collective interests of the Commission should be promoted and that these included restoration of the stock of minke whales.

Argentina repeated its full support for the moratorium and highlighted that scientific researchers who were studying the stock structure of the minke whale in the North Pacific have not yet been able to determine whether this is a single stock or whether there are two or more stocks and that there were three different hypothesis under discussion. Therefore, before the IWC could permit any type of catch it should have the report of the Scientific Committee on the implications that this type of hunting could have. On a separate matter, Argentina referred to a report by the Cetacean Research Institute indicating that of the 1,200 tons of whale meat hunted in the north west Pacific over 75% remained unsold even though it had been offered to market. In light of this, Argentina asked why it was necessary to permit coastal whaling.

Colombia understood and respected people's rights to food security. Nevertheless it did not support the allocation of a small type coastal whaling quota because it did not agree with practices for lethal use that would put an end to the moratorium. Colombia was concerned that through this proposal a loophole might be opened to re-establish unregulated commercial whaling as occurs in the case of scientific whaling under Article 8 of the Convention. Costa Rica also stated that the proposal would open up commercial whaling and re-iterated its support for the moratorium.

Chile stated it could not support the proposal partly because the Scientific Committee had not finished its study but also because the stock structures were uncertain, there was a high level of lethal bycatch and there were concerns over scientific whaling. Chile considered that an exception to the moratorium would mean lifting the moratorium on commercial whaling. Moreover, in the light of the Scientific Committee's recent discussions on the levels of radioactivity found in whales and small cetaceans, Chile called on the Government of Japan to avoid any consumption of this type of meat. Brazil considered that the proposal was an exception to the moratorium and represented commercial whaling, which it could not accept for the reasons given above.

The Chair then closed the speakers list because of time constraints with several Contracting Governments still waiting to speak. In doing so he apologised to those Governments and also to the speaker from the IWMC World Conservation Trust who would not be called upon to speak as not all member countries had been able to take the floor. Japan thanked the countries who had expressed support and stated that although it had expected opposition to the proposal it also considered that small type coastal whaling had much in common with aboriginal subsistence whaling which the Commission had already supported. Japan requested that this agenda Item remain open to allow it to consult with other Contracting Governments on how to move forwards.

Upon continuing this Item later in the meeting, Japan confirmed that it had decided not to request a vote on the proposal contained in IWC/64/9 as it preferred to work through constructive dialogue leading to a consensus decision. Nonetheless, Japan stated that controversial issues need solutions and accordingly it proposed to form a small ad-hoc working group to serve as a forum to gain the cooperation of members to resolve the small type coastal whaling issues. The terms of reference of this group would be in line with Resolution 2004-2 which was adopted by consensus. The working group would identify the unresolved problems and priorities through discussion with relevant parties and the progress would be reported to the next Commission Meeting. The group would be supported by the Secretariat and its membership would be composed of five or six countries with interests in Japan's small type coastal whaling. Japan asked for endorsement of this proposal.

Australia supported by Ecuador and Cyprus indicated that its understanding of the Rules of Procedure was that a new document such as IWC/64/17 could only be considered if there was consensus to do so. Given there was no consensus and the document did not meet the 100 day circulation rule for draft Resolutions, these countries considered the document should not be discussed.

St. Kitts and Nevis said there were significant merits in Japan seeking redress for the issues faced by its traditional coastal whalers especially with regards to Resolutions that had previously been adopted by the Commission. It said it was unfortunate that there was reluctance to discuss Japan's proposal and highlighted that five years ago there was a strong possibility that the IWC may have met its demise and another regional organisation would have taken over its role. St Kitts and Nevis considered that the same situation was now occurring again and urged that Japan be allowed to keep the issue on the table.

Japan responded to the question of the need for prior circulation by referring to Rule J and highlighting that this rule referred to Schedule amendments, recommendations under Article VI and Resolutions. It said that IWC/64/17 was a proposal to establish a working group and was not a Resolution or Schedule amendment, and as such it was not necessary to have consensus. However Japan's basic stance of pursing constructive dialogue remained and that was the reason for requesting consensus agreement. It recognised there was no agreement to establish the small ad-hoc group at this meeting so it did not ask to continue discussion on this subject at IWC/64.

However, Japan observed that the purpose of the ICRW was to provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry so as to realise the sustainable use of whale resources. Japan noted that the Commission had never denied the commerciality of whaling in itself. In this connection, it further noted that the commercial whaling moratorium was intended not to impose a permanent ban on commercial whaling but to provide a temporal suspension within a limited time period so that the Commission could obtain scientific data which was deemed insufficient when the moratorium was adopted.

Emphasising that Japan's small-type coastal whaling had similar characteristics to those of aboriginal subsistence whaling, Japan stated its great regret that the two issues had not been treated equally but instead were based on a double standard, as was also shown in the denial of Japan's proposal to establish an ad-hoc small working group to seek options for resolving matters related to the small-type coastal whaling.

Japan explained that there had recently been increasing domestic pressure on the Government in Japan which included the voices of Japanese citizens as well as politicians that the Government should fundamentally review its approach to the IWC and that it should seriously reconsider its range of possible options such as withdrawal from the ICRW, establishment of a new organisation, and resumption of small-type costal whaling.

Japan concluded by stating it hoped to resolve the matter of small-type coastal whaling at the next Commission meeting. It intended to present a new proposal concerning this issue to the next Commission meeting after consultation with the member countries who share interests with Japan.

13. REVISED MANAGEMENT PROCEDURE (RMP)

13.1 Report of the Scientific Committee

13.1.1 General issues[25]

The main focus on this section was on the priority items presented to the Commission last year. The first item has been examined for some time. It relates to the plausible range of maximum sustainable yield rates, MSYR. This is used in the testing of the RMP. MSYR relates to the productivity of the stocks. The present range of values is from 1-7% of the mature component of the population. The issue of productivity is important to general issues of conservation and management and not just the RMP.

The objective of the MSYR review is to examine whether new information and data suggest that the existing range needs to be changed. A work plan has been agreed that should result in completion of the review at next meeting. Since two other items on the agenda depend upon the completion of this work, it has also been agreed that in the event that the expected analyses are not completed by next meeting, then the existing range will continue to be used.

A number of Committee agenda items under this topic are of a technical nature. Here, focus will be made on the remaining item that is of general relevance and this relates to abundance estimates. This topic is not only important to RMP discussions but also to the Committee's work on assessing any stocks.

The Committee has developed requirements and guidelines for conducting abundance surveys and for analysing these types of data, where the goal is to obtain acceptable abundance estimates. The guidelines have been periodically reviewed in the light of new developments and the Scientific Committee feels it is important to question whether guidelines related to the newer spatial modelling approaches should be included. Further examination has also been given to some of the requirements and guidelines for the traditional design-based approaches to make them clearer. To assist this process it has been recommended that a review should be available at next year's meeting.

13.1.2 Implementation process[26]

The *Implementation* and *Implementation Review* process follows requirements and guidelines developed by the Committee and approved by the Commission. *Implementations* and *Implementation Reviews* provide a robust framework for determining safe levels of anthropogenic removals (e.g. whaling, ship strikes, and incidental deaths in fishing gear) in the light of the Commission's conservation objectives and user objectives for commercial whaling. In general, the purpose of an *Implementation Review* is to examine new information to ensure that the extensive simulation testing which was undertaken during the original *Implementation* still remains adequate to make sure that the conservation objectives of the Commission are being met. The focus was again on priority items presented to the Commission last year.

13.1.2.1 WESTERN NORTH PACIFIC BRYDE'S WHALES

The first issue addressed was the timing of the *Implementation Review* for western North Pacific Bryde's whales. Normally these are scheduled to occur every six years. However, for logistical reasons the Committee has recommended that the review be delayed until 2016.

13.1.2.2 CENTRAL NORTH ATLANTIC FIN WHALES

Given the new information received by the Committee this year, it recommended that the North Atlantic fin whale *Implementation Review* be brought forward one year and take place next year.

13.1.2.3 NORTH ATLANTIC COMMON MINKE WHALES

Discussions continued on preparations for the 2014 *Implementation Review* for North Atlantic common minke whales. The Committee agreed to a workplan to ensure that the required data and analyses will be available for the review. This includes a joint workshop with the AWMP after the next annual meeting.

13.1.2.4 WESTERN NORTH PACIFIC COMMON MINKE WHALES

Due to the complexity of the situation, this *Implementation Review* has taken longer than expected. The complexity of the situation is mainly due to the nature of the stock structure hypotheses and the fact that the hunts are carried out during their migration. Despite these complexities, the work this year at both an intersessional workshop and at the Annual Meeting means that completion of the Review at next year's meeting is possible.

The efforts of last year focussed on ensuring that the computer models that are used to test the various proposed hypotheses are able to mimic the proposed hypotheses and fit the available data. This process is known as 'conditioning' and it was agreed that this has been successfully completed.

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[25] For a full account see JCRM 14 (suppl.), Item 5.
[26] For a full account see JCRM 14 (suppl.), Item 6.

Consideration was then given to the simulation trials that are to be used in the review stage. These trials are developed to ensure that the range of scientific uncertainty is fully tested and plausibility was then given to these trials. Plausibility plays a role in the review of the results, to make sure that the advice given is in accord with the Commission's conservation objectives. The Committee spent a considerable amount of time on this. Medium plausibility has been given to trials using all of the different stock structure hypotheses that were proposed. This is because consensus could not be reached over assigning any of them low plausibility.

To examine future conservation performance, the Committee has to model information from potential removals including potential whaling operations and bycatches, and information from potential survey plans. As reported last year, two governments presented information on potential whaling operations – Japan and Korea. These are incorporated into what are called 'management variants'. The Committee's advice is provided based on the conservation performance of these management variants. Next year, after reviewing the results of the simulation trials, the Committee will advise, which, if any, of these management variants meet the Commission's conservation objectives.

13.1.2.5 NORTH ATLANTIC SEI WHALES

The Committee reconsidered an outstanding request from Iceland for the Committee to evaluate the information available on North Atlantic sei whales to see if these data were sufficient to be considered a candidate for a future *pre-Implementation Assessment.* It is the Commission's responsibility to decide whether a request for an *Implementation* by a Government should go ahead. The Committee established an intersessional group to review the available information to see if it meets the *Requirements and Guidelines* for *Implementations* and *Implementation Reviews*. If the Committee agrees that the data do meet these requirements, then the Committee will ask the Commission for advice on whether or not the Scientific Committee should begin the *Implementation* process.

13.1.3 Bycatch[27]

The Scientific Committee addresses the issues of bycatch and ship strikes for a number of conservation and management reasons. These include the fact that under the RMP, recommended catch limits must take into account estimates of mortality due to human factors. In addition, such mortality can lead to conservation problems for populations other than those for which the RMP might be considered. Ship strikes are also discussed by the Commission's Conservation Committee and while entanglement issues are also discussed by the Working Group on Whale Killing Methods and Animal Welfare Issues. The Committee encouraged further activities that can help quantify mortality related to marine debris.

The Committee has been co-operating with FAO on bycatch and fisheries information. All bycatch information received by the IWC has been submitted to FAO. The Committee requests the Secretariat to contact the FIRMS collaborative partnership under FAO to see if it is still collecting fishery effort in a manner that will assist the Committee in estimating bycatch.

The Committee received papers on long-term records of bycatches off South Africa and off western Canada. Amongst other valuable information these papers confirmed the relationship between population size and density and the amount of fishing effort with respect to bycatch rates. The Committee recommended the continuation of such studies where they exist and the initiation of such studies where they do not.

With respect to estimating risks and rates of entanglement, the Committee was pleased to hear that the recent capacity building efforts in entanglement response under the auspices of the IWC that took place in Argentina had stimulated an analysis of southern right whale entanglement data.

The Committee welcomed the report of the second IWC workshop on Welfare Issues related to Large Whale Entanglement and endorsed its recommendations, including the proposed expert group and the establishment of a entanglement database. This is discussed further under Item 11 above.

The Committee's discussions on ship strikes were initially reported to the Conservation Committee. Those discussions can be found under Item 8.2 above.

13.2 Commission discussions and action arising

The USA supported by Mexico and Australia drew the Commission's attention to document IWC/63/15 which contained information on RMP catch limits calculated by the IWC's Scientific Committee. The current fin whale quota, which had been unilaterally approved by Iceland, was as much as three times higher than the potential sustainable limit calculated by the Scientific Committee. It also considered that at this time a sei whale pre-*Implementation Review* was not a priority. Iceland responded that the fin whale implementation had been on-going for some years and the quotas issued by Iceland were based on variant two which was one of the variants acceptable with research under the terms of the RMP. The catch limits had also been discussed under NAMMCO's Scientific Committee which concluded that the

[27] For a full account see JCRM 14 (suppl.), Item 7.

catch levels were sustainable and precautionary. Iceland felt that this was also supported by the work of the IWC's Scientific Committee. The United Kingdom supported the USA's comments and noted that the catch limit of 150 was still 1.7 times higher than would be allowed under the RMP even if the less conservative variant was considered acceptable.

Without compromising the moratorium on the killing of whales, India supported the Revised Management Scheme contains strong safeguards for the conservation of whales along with a robust compliance mechanism and an assurance on the implementation of the catch limits and other rules of the Commission. In this regard India was concerned at reports that some countries were not adhering to the RMP as agreed by the IWC and it asked Norway if it was at risk of exceeding its own quota this year in some of the zones where whaling takes place. Norway responded that it was about half way through its current catch season and that catch levels were below those of the previous few years because of weather conditions. It confirmed it would report details of the catch both next year and especially during the *Implementation Review* planned for 2014. There were no indications that numbers were being taken above the quotas calculated through use of the RMP.

During this Agenda Item the Government of the Republic of Korea announced plans to conduct special permit scientific whaling so as to improve the availability of data regarding the stock structure and abundance estimates of minke whales in Korean waters in relation to the *Implementation Review* of the western North Pacific minke whales. This announcement by the Government of the Republic of Korea and the associated Commission discussions are reported under Agenda Item 14.2 below dealing with new Scientific Permits.

The Commission noted the report of the Scientific Committee on this item and endorsed its recommendations.

14. SCIENTIFIC PERMITS

The Chair confirmed that since IWC/63 in 2011 Japan had issued permits for taking minke, fin and humpback whales in the Antarctic through its JARPA II programme and for taking minke, Bryde's, sei and sperm whales in the North Pacific through its JARPN II programme. Japan had agreed to continue suspending the take of humpback whales through its Antarctic research programme in the 2011/12 season so long as progress was being made in discussions on the future of the IWC.

14.1 Report of the Scientific Committee[28]

14.1.1 Review of results from existing permits

The Committee had developed and the Commission approved a process for full regular review of individual special permit programmes under a process known as 'Annex P'. For long-term programmes the review occurs around every six years. As part of that process there is a specialist intersessional workshop whose report, along with the Scientific Committee's review of it, is made available to the Commission. The first time that process was used was in 2009 for the 6-year review of results from the JARPN II programme. Following the experience gained during that review the Committee has developed improvements and clarifications to the process as discussed under Item 14.1.3 below.

In between these detailed regular reviews the Committee has agreed to receive only short annual reports on activities under the programmes at annual meetings with only brief discussions, leaving the major consideration to occur under the Annex P process. It is important to note therefore that the lack of comments in the Committee's report does not imply its support or disagreement with these programmes.

The Committee is preparing for a full review of the results of the now completed Icelandic research permit on common minke whales. The specialist intersessional workshop will be held during February/March of 2013 and the Scientific Committee will discuss the specialist workshop report during its 2013 meeting.

The first 6-year review of JARPA II is also now due. However, undertaking two reviews in parallel is logistically difficult and the Committee proposes that the Annex P process for JARPA II should begin after the 2013 Scientific Committee Annual Meeting. This would result in an intersessional specialist workshop during spring 2014 and the Committee's discussion of this will therefore occur at the 2014 meeting of the Scientific Committee.

14.1.2 Review of new or continuing proposals

Japan reported that there was no plan to change either of the existing JARPA II or JARPN II programmes and no new proposals were presented.

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[28] For a full account see JCRM 14 (suppl.), Item 17.

14.1.3 Procedures for reviewing scientific permit proposals

As noted under Item 14.1.1, the Committee has been reviewing how the Annex P process had worked when it was first used for the JARPN II review in 2009. Last year the Committee agreed additional guidelines to clarify the admittance of Scientific Committee observers who will now have the same admittance rights as proponents of the Permit, and further guidance to ensure that Panel member selection process will facilitate a full, fair, independent, balanced and objective review.

This year, again by consensus, the Committee clarified the interactions between its Data Availability Agreement rules, timetables for data availability, and the Annex P process. The full text can be seen in IWC/64/Rep 1, Annex P3. In summary, this clarifies that descriptions of the available data must be provided to the Committee at the Annual Meeting prior to the intersessional expert workshop, while the data themselves shall be available in electronic format one month after that meeting. Applications to use the data must be via the Committee's Data Availability Group and the timings of the submission and receipt of data are clarified, as is what is meant by collaboration and offers of co-authorship.

Given this agreement was only made at the present meeting, it was agreed that the proponents for the forthcoming final review workshop of the Icelandic programme will not have to follow the new timeline strictly but they have indicated that the data should be available by the end of September 2012.

14.2 Commission discussions and action arising

14.2.1 Discussion on review of existing permits

Japan noted that many scientific articles had been issued based upon the outcomes of its special permit programmes including 380 general articles and 170 journal articles (see paper IWC/62/20). Japan had also provided the data from its programs to the IWC's Scientific Committee and this had been received, referenced and recognised in the Committee's report. Japan emphasised that lethal special permit research was essential to answer particular questions, for example data on age composition and population dynamics. It urged the Commission to base its discussions on scientific factual evidence.

Norway, supported by Grenada, said that there could be no doubt that the Japanese research programmes, JARPA, JARPA II, JARPN and JARPN II had given and continued to give valuable information on a number of scientific questions including for example date on condition, age and stomach contents of minke whales, and on general questions about changes in the ecosystem of the Southern Ocean. Norway stated that some of these questions could not be investigated by the currently available non-lethal methods.

Iceland, supported by Grenada, recalled the long conversations on the utility of scientific permit research and concurred with the views expressed by Norway and Japan about the usefulness of the results obtained in the Scientific Committee based upon the special permit programmes. Iceland noted that a relatively small special permit programme comprising about 230 fin whales and 70 sei whales conducted by Iceland from 1986-1989 led to the publication of over 150 articles and scientific reports. Accordingly, Iceland strongly disagreed with views that scientific permit proposals have not produced any useful results.

Australia stated its view that there was no reason to kill whales in the name of science and that all necessary information for the proper and effective conservation and management of whales could be obtained by non-lethal means. It said that the special permit programmes conducted by the Government of Japan namely JARPN, JARPN II, JARPA and JARPA II and the programme previously conducted by the Government of Iceland had produced no agreed or substantiated research outcomes relevant to the work of the IWC and were unnecessary for the conservation and management of whales. This was all the more serious due to the potential impact of the open ended and generally expanding programs and their impacts on the status of some populations of whales. Australia referenced the discussions in the previous Scientific Committee reports which highlighted the many substantial, general, and specific objections to the purpose and operation of special permit whaling programmes and the lack of any genuine response to the scientific review processes. Australia believed it was an appropriate time for all Contracting Governments to combine their research efforts under carefully designed non-lethal programmes such as the Southern Ocean Research Partnership.

Australia went on to state that there was a solid scientific basis for the criticism that that it and many other countries had offered on the utility of the data from lethal special permit research. There was no information and no science that is required and is useful for the conservation and management of whales that cannot be delivered through non-lethal techniques. Whilst there was a debate in the Scientific Committee over some current data the Committee had not been able to conclude any useful conclusions from that data and most of the discussion revolved around details of the analysis and flaws in the way the data were collected. Australia said that its scientific criticism of the special permit programs that went well beyond any political, or ethical, or welfare issues. Norway responded to Australia intervention and said that Article VIII did not relate only to information relevant to the management of whaling and whales; instead Article VIII included all relevant science. Noting the publication of results in the scientific literature, Norway said that valuable scientific information was being generated by both the JARPA and JARPN programmes.

New Zealand opposed Scientific Permit whaling under Article VIII as it believed that modern science techniques could increase understanding and conservation of whales without killing them. New Zealand took particular exception to whaling in the Southern Ocean whale sanctuary. Japan's two scientific whaling programmes in the Antarctic and in the Northwest Pacific had not, in New Zealand's view contributed meaningfully to species management or conservation. New Zealand fully supported and collaborated in the Southern Ocean research project undertaking successful non-lethal whale research within the Southern Ocean.

Mexico stated that the JARPA and JARPN programmes and all of their derivatives had contributed little to science and have done very little to improve the stocks of whales. Mexico drew attention to the errors in the programmes and stated that the results had not been encouraging in relation to the many years over which whales had been killed. For example natural mortality had been estimated at 0.04 with confidence levels so broad that it was impossible to say whether any increase or change had been experienced by the population and so the matter remained unknown. Thus the central objectives of the programme had not been met.

Monaco noted the publications which had been generated by the special permit programmes and reflected on the merits of individual papers. It questioned whether the scientific papers had affected knowledge and paradigms on cetacean science, and it asked why it was necessary to kill cetaceans for research when so many other study opportunities were available through bycatch and stranding events.

The Global Guardian Trust (GGT) said that as a conservation body its purpose was to promote the sustainable use of natural resources and to use the best available scientific information as the basis for conserving all living natural resources. Article VIII of the ICRW was critical to the proper operation of the IWC and the Chair of the Scientific Committee had reported that the scientific permit whaling had provided important information. Hundreds of scientific papers had been produced and peer reviewed. Some people took the view that this type of information was not of any interest to them and therefore that scientists should not undertake the research. But just as in the context of indigenous whaling, the preferences of some should not be allowed to subvert the activities of others. Understanding the biology of whale populations was one of many areas of scientific research. Research should take place when there is an identified need, not when there is a global consensus that it should be carried out. There was a need to understand the biological status of whale populations in order to be able to establish appropriate management mechanisms in the future. GGT asked delegates to recognise that scientific permit whaling had produced useful information that had a clear application in the future management of whale stocks and the sustainable use and conservation of whales.

14.2.2 Discussion regarding new proposals

PLANS BY THE GOVERNMENT OF THE REPUBLIC OF KOREA TO CONDUCT SPECIAL PERMIT SCIENTIFIC WHALING

The Republic of Korea stated that it was considering conducting whaling for scientific research in its waters in accordance with Article VIII of the Convention[29]. The Republic of Korea had a long history of whaling and whale meat was still part of the dietary tradition in some local areas such as Ulsan. However the long tradition of coastal whaling was suspended in 1986 in compliance with the IWC's decision and the Korean Government had to scrap all whaling vessels, promising that whaling would resume upon the recovery of resources. With this, Korean fishermen had been waiting for the IWC to lift the ban for more than 25 years. The Republic of Korea had respected the moratorium since it entered into force in 1986. Whaling was banned and subject to a strong punishment. The moratorium put significant social and economic burdens on people in some areas of Korea. Therefore, local people had constantly requested the Government to allow limited whaling. The local people said that minke whale populations had recovered to the level maintained before the moratorium and the increased numbers of whales were eating a huge amount of commercial fish stocks which should be captured by fishermen.

Since 2001 the Korean Government had been conducting non-lethal sighting surveys to assess the state of the stock and estimate of abundance of whales in the Korean waters. However these surveys could not identify different whale stocks and it was regretful that the survey results could not support discussions within the Scientific Committee on the number of whale stocks in Korean waters[30]. In addition, sightings only surveys could not identify feeding habits of marine mammals and contribute to understanding the impacts of whale populations on fisheries resources as a whole. Therefore the Korea Government had been forced to consider conducting whaling for scientific research in order to calm the complaints of Korean fishermen and to make up for the weaker aspects of the non-lethal sighting survey.

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[29] See also the Republic of Korea's Opening Statement; document IWC/64/OS Korea.

[30] In an intervention under Agenda Item 13 the Republic of Korea referred to the report of the Scientific Committee made at Agenda Item 13.1.2.4 which announced that the *Implementation Review* of minke whale stocks in the North West Pacific was scheduled for completion in 2013. The Republic of Korea noted that there several controversial points on the stock structure and population estimates of minke whales in Korean waters and highlighted its concern that the limited information on biological parameters may make it difficult to distinguish the stocks. Therefore the Government of the Republic of Korea said it was planning to conduct scientific whaling to improve the data availability and to elaborate on the existing information on stock structure and abundance estimation. Korea hoped that the working group would finalise the RMP *Implementation Review* on the basis of sufficient scientific data and evidence.

The proposed scientific research programme would be designed to analyse biological and ecological data on minke whales migrating off the Korean Peninsula. The programme would provide scientific information on stock structure using genetic analysis as well as the nature of interactions with fish stocks. The Korean Government said it was planning to submit a detailed research plan to the next meeting of the Scientific Committee and would take appropriate steps to gain validity for the scientific whaling research through relevant expert workshops. No decision had yet been made regarding the number of minke whales to be taken, the research period or the research area. However, the research would be done within the national jurisdiction of the Republic of Korea. It hoped that its research plan would be given the highest consideration at the next meeting of the Scientific Committee so as to take into account the severe difficulties of Korean fishermen as well as the scientific justifications to conduct this research.

St. Kitts and Nevis respected the right of all Contracting Governments to engage in scientific research under special permits and urged other members to do the same. It said that the IWC had benefitted from research results that had been obtained under special permits in the past and it viewed this type of research as valuable and critical. St. Vincent and The Grenadines and Grenada recognised scientific permit whaling and respected the rights of states to conduct research under the Article VIII of the Convention. It believed that scientific research was fundamental to the management of marine resources and it endorsed research proposals which followed the stipulated guidelines under Article VIII.

Norway supported the right to scientific research including the right to issue special permits under Article VIII of the Convention. It highlighted the need to follow and strictly adhere to scientific protocol when whales are taken under special permits and recognised that valuable knowledge on whales and ecosystems was undoubtedly collected through this type of scientific activity.

The Russian Federation stated its general support for scientific research. It said that the scientific results from the Japanese research programmes were interesting for understanding the situation with the whales and their habitats in Antarctica

Mexico, the USA, Colombia, Australia, Argentina, Panama, Ecuador, Germany, Monaco, the United Kingdom, New Zealand, Switzerland, Cyprus on behalf of EU member states party to the IWC, India, Chile, South Africa, Brazil all expressed their concern at the announcement by the Republic of Korea. Denmark expressed its wish not to participate in discussions on scientific whaling.

Mexico stated that the announcement by Korea was worrying and would bring greater pressure on the J-stock especially in regards to the number of entangled individuals. Mexico commented that the objectives of the JARPN programmes had not yet been met and that this second research effort would very likely reach the same result as the Japanese programme.

The USA continued to oppose lethal scientific research whaling programs and believed the scientific data needed to improve management and promote recovery of large whale populations could be collected through non-lethal means. It said that lethal scientific whale research, although allowed under Article VIII of the ICRW, was unnecessary for modern whale conservation management. It encouraged the Government of Korea to follow Annex P which required submission of information six months prior to the Scientific Committee meeting at which it was to be considered. The USA also understood that takes of minke whales in this area would be composed 100% of J-stock animals which would be of considerable concern to the IWC.

Australia reiterated its view that there was no reason to kill whales in the name of science and that all necessary information for the effective conservation and management of whales could be obtained by non-lethal means. It invited the Republic of Korea's scientists to visit the Australian Marine Mammal Centre in Hobart so as to discuss the use of non-lethal techniques to help solve some of the data shortages.

Cyprus spoke on behalf of the EU member states party to the IWC to indicate its strong regret that the Republic of Korea was considering undertaking whaling for scientific purposes. It noted that the impact of whaling on the North Pacific minke whales was being evaluated by the Scientific Committee and that the impact on the endangered J-stock must be considered carefully so as to avoid catches on this stock. It noted that the minke population of the North Pacific was already subject to very high levels of bycatch. Given the unknown effects of taking any numbers in the area concerned precaution should prevail. Cyprus stated its disagreement with the conclusion set out in the opening statement of the Republic of Korea, and highlighted its disagreement with the sentence which read 'minke whales are eating away large amount of fish stocks which should be consumed by human beings'.

Germany reported that there was a broad consensus in the German parliament across all political parties to stop scientific whaling as soon as possible. Germany believed that non-lethal research was the correct approach to improve knowledge of whales. All activities in this field should be continuously enhanced and promoted in contrast to scientific whaling which did not have an added value regarding knowledge on whales. Germany was also deeply concerned that scientific whaling would open the door to commercial whaling.

Monaco asserted that scientific whaling was an obsolete legacy of a Convention drafted 60 years ago. Since that time cetacean science had moved on and given the enormous body of scientific literature and other non-lethal ways of studying cetacean ecology there was no reason to kill cetaceans on the pretext of science. Monaco noted that Asian science in particular was progressing well and that there was no doubt that scientists from Korea could take advantage of the non-lethal techniques and enormous body of scientific papers on this subject.

The United Kingdom considered Special Permit whaling programs to be unnecessary and of questionable value scientifically. There were perfectly adequate non-lethal alternatives which could secure the information required by the IWC for stock assessment and management purposes. The UK noted that the impact of whaling on the North Pacific minke whales is currently being evaluated by the Scientific Committee and the need to avoid catching whales from the endangered J-stock would need to be looked at carefully so as to avoid depletion. Japan responded to the United Kingdom intervention by drawing attention to the report of the Scientific Committee[31] which listed the catch data obtained through the special permit catch as having been received by the IWC and thus were therefore scientific data. Japan also noted that the Scientific Committee had agreed that the available information was sufficient to warrant an *Implementation Review*.

New Zealand noted that the Scientific Committee had already undertaken a considerable amount of work through its *Implementation Review* on North Pacific minke whales around Japan and Korea. Extensive research and analysis covering issues related to stock structure and abundance estimates had already been completed on the minke whales on which Korea is proposing to undertake lethal research. The J-stock minke whales in this area are seriously depleted and New Zealand strongly believed that lethal scientific whaling on this stock was unnecessary. New Zealand was strongly opposed to the Republic of Korea's proposal.

Switzerland recognised the rights of Contracting Governments to undertake whaling through special permits. However it urged all Contracting Governments to redesign scientific whaling programmes and abstain whenever possible from lethal research.

India's position was in favour of the moratorium and it expressed concern about the large number of whales being killed for scientific research. Research methods should be developed to reduce the killing of whales for research. While not compromising the moratorium, the countries concerned should issue scientific permits on a minimum needs basis which included a comprehensive evaluation of the objectives of such research and appraisal of the performance of such permits.

Chile stated that scientific research programs were not necessary for whale conservation and management nor were they relevant to the Commission's endeavours. Regarding the Republic of Korea's request, Chile believed that the largest bycatch of whales occurred in that country and therefore no scientific research programs should be necessary as those individuals should be used then for study purposes. Chile expressed its rejection of the years of legal excuses which had allowed undercover lethal research to be carried out in the Southern Ocean.

South Africa recognised that science had made many advances since the Convention was created in 1946. With many new non-lethal methods to obtain data there was no longer any need to kill animals. South Africa did not support any lethal scientific whaling and respectfully asked the Republic of Korea to reconsider its plans to start lethal scientific whaling and rather explore other non-lethal methods to obtain the necessary scientific data.

Brazil commented that other non-lethal methods were available to research cetacean populations and therefore it had strong objections to those countries that continued to use lethal methods. Accordingly it encouraged other countries, including Korea, not to undertake or start to undertake lethal research.

The Republic of Korea acknowledged the comments regarding its proposed plan for scientific whaling and said that it was under no obligation to inform the Commission in advance of any plan. However it said that it was under obligation to submit the relevant papers six months before the Annual Meeting and confirmed that it was prepared to do this in a spirit of trust and transparency as a responsible member of the Commission. It did not accept any proposition that whales should not be killed or caught. The IWC was not a forum of moral debate and instead was a forum of legal debate. Accordingly Korea requested that discussions should focus on legal arguments.

14.2.3 Discussions on procedures for reviewing Scientific Permit proposals

Chile expressed its concern about the Scientific Committee's permit review process which was delegated to a small, closed group of experts as this led to the Committee as a whole being unable to examine in detail the results of the programmes. This in turn led to very little discussion within the Committee. Chile believed that the permits should be examined at the Committee level given it is the body responsible for the management and review of special permits. Monaco supported Chile's comments and asked for improvements in the Scientific Committee's reporting of its

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[31] IWC/64/Rep 1

discussions on special permits. It noted that there was often no consensus within the Committee on matters related to special permits but asked for the opposing arguments and evidence to be presented to the Commission.

COSTS OF SPECIAL PERMIT REVIEWS[32]

Australia, supported by Mexico, Monaco, USA and the United Kingdom highlighted the upcoming intersessional workshop to review Iceland's special permit whaling programme and the associated costs of £24,000 included in the proposed research budget. Noting the Commission's budgetary problems and the scaling back of the overall Scientific Committee funding Australia strongly suggested that there was no benefit in having the workshop paid for by the Commission and instead it proposed re-allocation of those funds to areas which were not included in the Committee's budget. The USA understood that only about 200 minke whales were taken before Iceland commenced its commercial whaling and therefore the examination of the data could easily be folded into a future review. Accordingly the USA recommended that the review of the data be delayed until a future date.

Iceland opposed suggestions to postpone the review of its special permit programme. It confirmed that the programme operated from 2003-2007 and that approximately 200 minke whales were taken. Iceland said the program was justified and conducted according to the ICRW. It noted that the Scientific Committee had proposed the review and that the proposal had been adopted by the Commission. Accordingly Iceland had been preparing for the independent review during the forthcoming winter in accordance with the Annex P process. It recognised that if the Commission did decide to cancel the review then it would have to accept the decision. However Iceland highlighted a wide range of scientists had been involved in the programme and some of these had been engaged on a temporary basis. If the review was to be postponed or held at a location outside Iceland many of the scientists would not be available. It also recalled that when Iceland agreed to the review programme there was a clear understanding that the costs would be paid by the IWC.

Responding to Iceland's comments, Australia said that it was important that the special permit programme was reviewed given the previous controversy and criticisms which surrounded it. It clarified that it was the timing of the review and who should fund it that was being questioned.

Norway supported Iceland's wish for the review of its research programme to be carried out according to the original plans, and considered it to be a disregard of the Scientific Committee if the review did not proceed.

Discussions on the future work plan of the Scientific Committee and the review of the Icelandic special permit programme were concluded under Item 19.4.2.

The Commission noted the report of the Scientific Committee on this item and endorses its recommendations.

15. SAFETY ISSUES AT SEA

This agenda Item was included at the request of the Government of Japan who stated that since 2005 the vessels conducting the JARPAII programme had experienced on-going violent protests and acts of sabotage arising from the actions of the Sea Shepherd Conservation Society. These protest activities had included illegal boarding of ships, collisions between vessels, use of improvised weapons and efforts to entangle vessel's propellers. Japan drew attention to its efforts to resolve this issue through international cooperation including the adoption of Resolutions and statements criticising The Sea Shepherd Conservation Society by the International Maritime Organisation (IMO) and by the IWC[33]. Japan stated that it had obtained arrest warrants for five Sea Shepherd activists and had approached governments who were either port or flag states for Sea Shepherd vessels. However, despite these actions no effective measures had been taken against Sea Shepherd and Japan called for the implementation of other approaches including the inspection of Sea Shepherd vessels, the prohibition of departure of Sea Shepherd vessels from port, the strengthening of monitoring of Sea Shepherd members and access to information regarding any preferential treatment including tax and subsidies.

Antigua and Barbuda emphasised the seriousness of issues surrounding safety at sea and said that countries who acted as flag or port states for Sea Shepherd vessels had an additional responsibility to conduct themselves in an acceptable manner. St Vincent and The Grenadines supported by Tanzania highlighted the responsibility for the protection of human life and said that the reality was that neither flag nor port states would take action. St Kitts and Nevis recorded its sympathies for the crew and scientists of the research vessels and said that Sea Shepherd was operating without fear of reprisals or sanctions from port or flag states or the country where it was registered. It noted that the Sea Shepherd actions had prevented the Southern Ocean sighting surveys from taking place and anticipated that the increased protest actions would ultimately lead to lives being lost.

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[32] See also discussions under Agenda Item 19.4.2 on the Scientific Committee's proposed work programme.

[33] See Resolution 2006-2 on the Safety of Vessels Engaged in Whaling and Whale Research-related Activities; Resolution 2007-2 on Safety at Sea and Protection of the Marine Environment; the statement issued by the Commission at its intersessional meeting in March 2008 and Resolution 2011-2 on Safety at Sea.

St Lucia, supported by Norway, Kiribati and the Russian Federation stated that although the IMO was the primary organisation to deal with safety at sea the matter should also be addressed by the IWC because the data collection work being undertaken by the IWC was being affected by Sea Shepherd's actions. St Lucia highlighted the seriousness of the issue and stated that it must be dealt with to avoid the possibility of fatalities in future years. Benin noted that the question of safety was linked to the opportunity to carry out research, and accordingly the solution to the problem lay with the IWC. The Russian Federation called upon the IWC and flag and port state countries to take measures to stop Sea Shepherd operations.

Norway, supported by Iceland, expressed its support for the Japanese seamen and scientists and expressed regret that the research activities in the Southern Ocean could not be carried out as planned because of the violent actions. It called on states not to support the activists and to use the legal means at their disposal to pursue them. It said that passivity was indirect support, which was dangerous as it undermined diplomatic attempts to handle the controversy. Norway urged all parties including relevant flag and port states to be clear in their message and in their actions to prevent activities that put at risk human lives and property at sea. It noted that in mid-May 2012 Paul Watson had been arrested in Germany. At the time of this meeting he was awaiting extradition to Costa Rica on charges of endangering people's lives by interfering with legal fisheries operations.

Guinea attached great value to the research conducted under JARPAI and II and recalled that these programmes showed that some whales fed exclusively on pelagic species. Given that the peoples of some countries were also consumers of small pelagic species, Guinea attached great importance to the food security relationship between fish and whales. Accordingly it condemned all activities which jeopardised scientific research.

India endorsed the IWC's Resolutions on safety at sea and shared Japan's concerns. It was opposed to violent protests at sea by any organisation but also recognised the rights of an individual or organisation to express their protests in a peaceful manner within the ambit of the law of the land and international rules and regulations. Kiribati, The Republic of Korea and Iceland supported the right to legitimate and peaceful protest but expressed concern over further escalation in the confrontations. They urged flag and port states to take the necessary actions to discourage the violent protests.

Australia stated that on matters associated with safety at sea nothing less than full compliance with domestic and international laws was acceptable. Australia had fulfilled and would continue to fulfil all of its international legal obligations arising from events in the Southern Ocean. However its view was that the IMO was the appropriate forum to address safety at sea matters, not the IWC. The Australian Government respected the right to peaceful protest but did not condone and had repeatedly condemned dangerous, reckless or unlawful behaviour, including on the high seas. In January 2012, Australia's Prime Minister had made it clear that the actions of the three Australian protestors who boarded a Japanese vessel were unacceptable. In addition Australia referred to the joint Ministerial statement on Whaling and Safety at Sea released by the Foreign Ministers of Australia, The Netherlands, New Zealand and the USA on 14 December 2011 as a statement of its position on this issue.

The Netherlands was firmly opposed to any type of commercial or scientific whaling. It was disappointed and concerned about the repeated activities of the Japanese whaling fleet in the Southern Ocean Sanctuary as it constituted a violation of the sanctuary's intent. There was no necessity to kill whales for scientific purposes as there were sufficient non-lethal research methods available. Japan had yet to demonstrate such a need, and NGOs were therefore all the more likely to continue to protest. It called on Japan to end this practise. The Netherlands remained of the opinion that safety at sea did not fit within the remit of the IWC as the appropriate forum for any discussion in the field of maritime safety was the IMO. The Netherlands remained committed as a flag state and called upon the masters of all vessels to strictly observe the IMO's international collision avoidance regulations. It referred to the joint statement made with the Governments of Australia, New Zealand and the USA published on the 14 December 2011 which underlined that any unlawful activities should be dealt with in accordance with the relevant international and domestic laws. The Netherlands fully respected the right to protest peacefully, including on the high seas, but deplored the incidents between ships of the Japanese whaling fleet and the Sea Shepherd Conservation Society during the 2011/12 season. The Netherlands remained particularly concerned about the apparent escalation of violence in such incidents and had, on a number of occasions, discussed these and related matters bilaterally with Japanese representatives both in the Hague and Tokyo with a view of better understanding each other's position.

New Zealand took issues of safety at sea seriously and insisted that all persons operating on the high seas comply with international standards of safe navigation, particularly in the harsh conditions of the Southern Ocean. New Zealand acknowledged its international obligations and said that it would take and had taken appropriate action where obligations required it to conduct investigations and establish jurisdiction. This included the case where New Zealand's maritime authority carried out a full investigation into the incident in the Southern Ocean that led to the sinking of the New Zealand registered *Ady Gil* during the 2009/10 whaling season. That investigation found that the masters of both vessels involved engaged in conduct that resulted in the collision. New Zealand understood Japan's concerns about Sea Shepherd's operation in the Southern Ocean and had repeatedly called on Sea Shepherd vessels operating there to act responsibly. It was very concerned that there would be a serious incident leading to loss of life or serious injury. Since the sinking of the *Ady Gil* New Zealand was not a flag state to any Sea Shepherd vessel. It noted that the Sea Shepherd Organisation had stated its intention to return to the Southern Ocean to protest against Japan's special permit whaling for as long as Japan continued to undertake whaling in the Southern Ocean Sanctuary. New Zealand respected the rights of individuals and groups to peaceful protest, including on the high seas, but it did not condone violent protests that endangered life or property.

The USA stated that the safety of vessels and human life at sea was its highest priority and it condemned acts that intentionally jeopardised crew members' lives or the safety of vessels. It was deeply concerned that confrontations in the Southern Ocean could lead to injury or loss of life of the whaling crews and protesters. In 2010 and 2011, the United States had joined Australia, The Netherlands and New Zealand in calling for responsible behaviour in the Southern Ocean and urged the masters of all vessels to observe international collision avoidance regulations. The USA continued to support the comprehensive set of instruments at the IMO to promote, enhance and protect maritime safety.

Brazil, Chile and the Dominican Republic supported all efforts to strengthen safety at sea. However, it noted that the issue fell within the remit of the IMO which had the appropriate instruments and mechanisms to deal with such questions which were also related to the jurisdiction of flag and port states. Brazil condemned any acts of violence at sea, but at the same time supported the rights of individuals and organisations to freely demonstrate. It regretted that special permit whaling operations in the Southern Ocean Sanctuary were at the origin of such incidents. Colombia, Chile and the Dominican Republic condemned all violent actions related to safety on the high seas but considered that this issue had been addressed at IWC/63 in 2011[34] and stated that the matter should now be referred to the IMO. The Dominican Republic recommended that the Government of Japan reconsider its scientific whaling as it was not worth risking the lives of Japanese researchers in such a situation.

Japan thanked those delegations who expressed concern and support. It drew attention both to Resolution 2011-2 which urged all Governments concerned to continue to co-operate to prevent and supress actions that risk human life and property at sea and to IMO Resolutions which encouraged Governments to co-operate. Noting that the 2011-12 JARPAII scientific survey had been disrupted it said that this was a serious loss of scientific knowledge for the IWC as it represented the only dedicated cetacean data in that region of the Southern Ocean. Japan repeated its call for all governments to cooperate in taking action to address the issue. Australia clarified that the information collected through JARPAII was not the sole source of cetacean information collected in that sector of the Southern Ocean as substantial cetacean research was also conducted by the USA, France, Australia, New Zealand and other nations.

Mr. Chikimasa Ohkoshi of the International Transport Workers' Federation (ITWF) said that it supported the efficient use of whale resources when they were sustainably available. It had carried out research in the Southern Ocean over many years to provide the IWC's Scientific Committee with valuable data, but Sea Shepherd had consistently put the boats and lives of its crew members at risk. Such malicious activities were condemned every year at the IWC, but again this year Sea Shepherd had carried out sabotage acts. It stressed that it was nothing but sheer luck that no one was injured by persistent attacks. The ITWF asked that standards for international seamanship be applied to Sea Shepherd. Forcing others to change their opinions with violence was not acceptable and was terrorism. It hoped that the flag states of the anti-whaling vessels fulfilled their obligations as members of the international community and also asked any member state which allowed Sea Shepherd vessels to call at their ports for refuelling to review whether they were meeting their obligations. ITWF felt that such actions were no different to supporting a terrorist group.

Mr Ohkoshi said that he was a gunner of a catcher boat and had been engaged in the research whaling for nineteen years. ITWF's members were working hard doing their job and they had a right to do their work safely. On behalf of all the fishing workers in the world, the ITFW protested against violent campaign activities and requested that all the IWC member countries take a firm attitude against Sea Shepherd's actions.

16. CATCHES BY NON-MEMBER NATIONS

16.1 Report of the Scientific Committee

Last year, the Secretariat contacted both Canada and Indonesia to request information on recent catches. No response came from Indonesia. Canada kindly responded and provided catch information on the 2011 bowhead catches which was considered by the Scientific Committee under their agenda item 7.3.4.1. The Secretariat has been requested to continue to ask for information on this issue.

16.2 Commission discussions and action arising

The Observer from the Government of Canada confirmed that it had submitted data to the Scientific Committee regarding the 2011 Aboriginal Subsistence harvest of bowhead whales by the Canadian Inuit. Canada was pleased to

[34] Resolution 2011-2.

share this information with the Committee and would continue to co-operate with the IWC's Scientific Committee in the future.

There were no further discussions under this Item and the Commission noted the report of the Scientific Committee on this item and endorsed its recommendations.

17. INFRACTIONS, 2011 SEASON

The Infractions Sub-committee met in Panama on 25 June 2012. Lars Walløe (Norway) chaired the meeting which was attended by 22 Contracting Governments. The full report of the Sub-committee is available at Annex H.

A summary of catches by IWC member nations in the 2011 and 2011/2012 seasons is provided at Annex I.

17.1 Report of the Infractions Sub-committee

The Chair of the Sub-committee referred to the infractions reports received in 2011 which were tabulated in Appendix 3 of its report. The Chair described the Sub-committee's discussions regarding the take of a bowhead calf in September 2011 and also the follow up to earlier infractions reports by Denmark (Greenland), Iceland, Korea and a 2009 infraction report by Norway involving the use of a cold grenade harpoon. The Chair also reported on surveillance of whaling operations, on information required or requested under Section VI of the Schedule to the ICRW (1946), and on submissions of national laws and regulations.

17.2 Commission discussions and action arising

There were no discussions under this agenda Item. The Commission noted the report of the Infractions Sub-committee and endorsed its recommendations.

18. ENVIRONMENTAL AND HEALTH ISSUES

18.1 State of the Cetacean Environment (SOCER)

18.1.1 Report of the Scientific Committee[35]

The SOCER report uses peer-reviewed literature to provide an annual update on environmental matters that potentially affect cetaceans. It is tailored for a non-scientific audience and this year focused on the Indian Ocean. The primary source of information was the International Indian Ocean Cetacean Symposium, held in the Maldives in July 2009. In general, the authors concluded that awareness of environmental-related threats to cetaceans is high in this region, although implementation and control measures are not. Information is scant or absent in many areas with most research focussed in a few locations. There will be fifteen new peer-reviewed papers from this region in the next issue of the *Journal of Cetacean Research and Management*.

Next year the focus of SOCER will be the Atlantic Ocean with an emphasis on papers published between 2011 and 2013.

18.1.2 Commission discussions and action arising

Cyprus spoke on behalf of the EU member states party to the IWC to welcome the work undertaken through the SOCER report, which provided a non-technical period summary of the positive and negative events affecting conditions in the marine environment. It noted that environmental degradation from a number of sources had taken their toll on the state of the marine environment and many of those were of increasing conservation importance. It believed that sound science was essential to enhancing the conservation status of whales and stated its appreciation for the work of the IWC's Scientific Committee.

18.2 POLLUTION 2000+ research programme

18.2.1 Report of the Scientific Committee[36]

The IWC's POLLUTION 2000+ programme has been one of the Scientific Committee's successful international collaborations. It is examining the complex and difficult issue of the effect of chemical pollutants on cetaceans and cetacean populations. Phase I of the programme was completed in 2008. Phase II is focussing on trying to examine population level effects. Its four objectives are to: (1) improve the existing concentration-response function for PCB-related reproductive effects in cetaceans, which was largely completed in 2011; (2) integrate improved concentration response components into a population risk individually-based model for two case study species (the bottlenose dolphin and the humpback whale), again largely completed in 2011; (3) derive additional concentration-response functions to address other endpoints (e.g., survival, fecundity) in relation to PCB exposure, which was discussed this year; and (4)

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[35] For a full account see JCRM 14 (suppl.), Item 12.1.

[36] For a full account see JCRM 14 (suppl.), Item 12.2.

implement a concentration-response component for at least one additional contaminant of concern, which has not yet been completed.

This year, progress on the third objective was provided from an IWC funded project. This used a modelling framework based on individual animals to examine how possible effects on pollutants on the immune function of individuals was reflected at the population level. In the examples chosen, the focus was on the potential effects of polychlorinated biphenyls (PCBs) on breeding females from bottlenose dolphin populations in Florida and Georgia. The model prediction for Florida, which has low PCB levels, was that they would remain stable or increase slightly over the next 50-100 years. However, the population in Brunswick, Georgia is predicted to decline over the same period. In this area, PCB levels in breeding females are 10 times higher than in Florida.

The Committee commended the authors for this work and strongly supported their continued programme to develop the necessary tools for analyses of pollutant exposure risk to cetaceans. The programme will continue this year and the Committee has provided additional advice to the researchers. The Committee also strongly recommended that the bottlenose dolphins in Brunswick, Georgia are monitored given their extremely high PCB levels.

18.2.2 Commission discussions and action arising

There were no discussions under this Item.

18.3 Cetacean diseases

18.3.1 Report of the Scientific Committee's working group on Cetacean Emerging and Resurging Diseases[37].

The CERD (Cetacean Emerging and Resurging Diseases) working group was formed in 2007 to increase research and standardise reporting in a wide range of disciplines dealing with the health of cetaceans. For example, a two-level CERD component to the IWC website is being developed with the help of the Secretariat. The first public level will provide basic information on diseases in cetaceans, as well as access to selected discussion forums. The second level is for registered users and will include in-depth disease information, as well as the ability to post and map locations of disease incidents and to discuss events with professionals. Standardised tissue collection protocols will also be included on the website.

The Committee also received several interesting papers on diseases in cetaceans this year: a paper on *Morbillivirus*-infested cetaceans that stranded along Italy between 2009 and 2011; a paper on organochloride contaminants (such as DDT) which were high in gray whales calves from Mexico; and a paper on the diseases and microorganisms that impact cetacean strandings along Costa Rica during 2004-2011, where some cetaceans diseases, such as *Brucella*, can also affect humans.

The Committee welcomed these papers and recommended additional research be conducted on pathogens, particular those like *Brucella*.

18.3.2 Commission discussions and action arising

The USA noted that 2012 marked the 20 year anniversary of its Marine Mammal Health and Stranding Response Program. This Program leads the investigation of unusual mortality events which are declared in the USA when a stranding event or disease outbreak is unexpected, involves a significant die off of any marine mammal species and demands an immediate response. As of May 2012 the program had investigated 56 unusual mortality events in the USA with four events currently under investigation from the past year. Over the last several years the USA's collaborations with its partners had documented new viruses, new bacterial diseases and new fungal diseases in cetaceans in the wild. Over the past year the program has investigated the role of emerging infectious diseases on marine mammal health, the transport of terrestrial pathogens to marine mammals, the risks of animal to human and human to animal transmission of shared pathogens and the emergence of pathogens in the marine food web[38].

Cyprus spoke on behalf of the EU member states party to the IWC to express concern about the health status of whales and especially small cetaceans. New scientific information showed that dolphins and whales were increasingly suffering from skin diseases, bacterial and viral infections which originated from a wide variety of pathogens. Cyprus highlighted the increased involvement of European scientists in the work of the CERD working group. It believed that IWC had a significant role to play in these areas of research and said that further work was important, especially as it is closely connected to other threats such as pollution, ship strikes and entanglement.

18.4 The impacts of oil and dispersants on cetaceans

18.4.1 Report of the Scientific Committee[39]

The Committee was provided with an update on the 2010 Deepwater Horizon oil spill in the Gulf of Mexico that started when a drilling platform collapsed in April 2010. In particular it was informed of a number of major projects being undertaken within the USA. The damage assessment process included a wide range of techniques including photo-

[37] For a full account see JCRM 14 (suppl.), Item 12.3.
[38] The Program's findings were described in detail in the USA's voluntary cetacean conservation report (IWC/64/CC5).
[39] For a full account see JCRM 14 (suppl.), Item 12.2.2.

identification, biopsy sampling, telemetry, live capture health assessments and evaluation of stranding data for common bottlenose dolphins in nearshore waters.

The Committee commended this research and strongly recommended continued investigations into the impacts on cetaceans of the oil and oil spill related contaminants, and to continue the health assessments.

The Committee has previously referred to the important issue of capacity building with respect to oil spills and cetaceans. This year it received information on several initiatives in this regard including a workshop at the 2nd International Conference on Marine Mammal Protected Areas. It is concerned about the potential problems of oil spills in the Arctic and the Committee agreed that the recommendations from that workshop[40] will provide a useful basis for discussions related to oil at the forthcoming Arctic Anthropogenic Impacts Workshop (see Item 18.9).

18.4.2 Commission discussions and action arising

There were no discussions under this Item.

18.5 Marine renewable energy developments and cetaceans

18.5.1 Report of the Scientific Committee[41]

The Committee held a Workshop on Marine Renewable Energy Development (MRED) in Panama immediately prior to this year's Scientific Committee meeting (SC/64/Rep6).

MREDs include wind farms, tidal-stream driven devices and wave energy converters. All are potential ways to make energy and mitigate climate change, but all have the potential for negative interactions with cetaceans during their construction, operation and decommissioning. The demand for this type of energy is increasing around the world. The Workshop received reports on the current state of development and management of these in Europe and the USA. Given the movements and migrations of cetaceans, trans-boundary issues are an important consideration. The Workshop developed, and the Committee endorsed, general principles and a strategy to minimise environmental threats posed by these developments. The Scientific Committee can assist in implementing aspects of this including: (1) assisting with international, collaborative research to determine baseline basic information about cetaceans that might be affected; (2) evaluating possible population impact assessments, especially those using modelling approaches that account for cumulative impacts from all sorts of threats; (3) designing monitoring projects to assess potential impacts; and (4) helping to promote data-sharing.

The Committee also reiterated its previous recommendations with respect to mitigation against noise which is also relevant to energy developments (and see Item 18.6).

Finally, the Committee was concerned to receive information on the development of MREDs in Chilean waters that are in critical cetacean habitat. It strongly recommended urgent development of environmental impact studies and noted the need for a precautionary approach.

18.5.2 Commission discussions and action arising

Cyprus spoke on behalf of EU member states party to the IWC and said that in the European Union marine renewable developments and especially wind farms were increasing rapidly. There were a number of research programmes to monitor and mitigate the possible effects of such installations. These effects included habitat alteration, entanglement, collisions, contamination and the impacts of underwater noise. However, in light of the potentially accumulative effects arising from other anthropogenic threats there was a strong need to develop alternative and quieter techniques for the construction of wind farms to avoid underwater noise. Moreover, comprehensive environmental assessment must be conducted during the development of renewable marine energy facilities and Cyprus was committed to work cooperatively towards the mitigation of negative effects on cetaceans.

18.6 Anthropogenic sound

18.6.1 Report of the Scientific Committee[42]

The Committee has often considered the issues surrounding the effects of noise on cetaceans. This year, the Committee discussed a paper that proposed a way to assess these effects. The first stage is to develop acoustic habitat maps integrating sound from multiple sources and overlay these with habitat maps of the spatial-temporal distribution and abundance of cetaceans. This can then assist in identifying areas or periods of concern and data gaps. This information can lead to the development of precautionary measures to protect marine mammals from potential impacts as well as prioritisation of research to fill in the data gaps.

The Committee was pleased to receive information on relevant US work, specifically the projects called CetSound and CetMap. It welcomed the development of mapping tools and recommended further development and improvements of

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[40] *http://second.icmmpn.org*.
[41] For a full account see JCRM 14 (suppl.), Item 12.6.
[42] For a full account see JCRM 14 (suppl.), Item 12.4.

the tools. It also welcomed the work being undertaken by the IUCN Western Gray Whale Advisory Panel and its Noise Task Force.

With respect to underwater noise from commercial shipping, it was noted that the IMO is working on guidelines related to noise from commercial ships; the Secretariat participates on the relevant IMO working group.

The Committee was pleased to receive an update on a major programme now known as PCoD (Population Consequences of Disturbance). It is envisioned that in the future, accumulative effects, behavioural responses and other factors, such as acoustic masking that could potentially affect health may be incorporated into the model. The Committee strongly encouraged further work on this model and looked forward to progress updates.

18.6.2 Commission discussions and action arising

The USA highlighted the report by the Scientific Committee which indicated that since 2011 it had been engaged in a project to improve evaluation of the impacts of human induced noise on cetaceans. As part of this project, the USA had convened two data and product driven working groups; the first one on underwater sound field mapping (CetSound) and the second on cetacean density and distribution (CetMap). The working groups completed their work in May 2012 and the USA held a symposium where their products were presented to scientists, NGO's, industry, Federal Agencies and local managers with a view to developing management applications. The USA expected that the final products and analysis would provide a biological and acoustic basis to inform subsequent management decisions. The USA supported the Scientific Committee's recommendations for further development of these tools and would continue to address ocean noise issues. It also encouraged the IWC to continue working with other international organisations, particularly the IMO as it works to develop ship quietening technology and reduce ocean noise. It further encouraged the IWC to explore new partnerships to further this work including potential collaboration with the Arctic Council. Mexico, Australia, Argentina and South Africa congratulated the USA on the development of CetSound and CetMap and described them as spectacular and sophisticated mapping packages which were incredibly useful for developing practical mitigation measures. Australia and South Africa indicated that they would like to collaborate intersessionally with the USA on further development and use of the tools.

Cyprus spoke on behalf of the European Union states party to the IWC and said that during the last century noise levels in the world's oceans had increased significantly as a result of multiple human activities. It said that the effects of noise ranged from disturbance of communication and group cohesion through to injury and mortality. It supported the Scientific Committee's work and especially its recommendation to improve mapping tools to depict the characteristics of both chronic and episodic underwater noise. Cyprus welcomed continued discussions between the IMO and the IWC regarding efforts to reduce the noise of newly built vessels. It encouraged efforts to develop a modelling tool to determine the population level consequences of acoustic disturbance on marine mammals.

18.7 Climate change

18.7.1 Report of the Scientific Committee[43]

The Committee has held two major workshops on climate change and one follow-up workshop on small cetaceans.

The Committee welcomed an update of a study related to the second climate change workshop's theme regarding single species-regional contrasts. This involved passive acoustic sampling from two recorders in the Atlantic and Pacific sectors of the High Arctic during 2008-2009 and revealed a seasonal difference in occurrence of bowhead whales in the high Arctic. The Committee was also pleased to receive information from a programme known as SOAR (the Synthesis of Arctic Research) which, although not focussed on cetaceans, includes some projects involving white whales and bowhead whales.

18.7.2 Commission discussions and action arising

India said that it had researched the impacts of climate change, including the impacts on marine mammals, as part of its overall climate change assessment. While the efforts to address climate change can be national and regional, the causative factors are global and cannot be attributed solely to developing countries. The actions and efforts to understand the effects of climate change that are undertaken by the developing countries must be supported financially and technologically by the developed whaling nations.

18.8 Ecosystem modelling

18.8.1 Report of the Scientific Committee[44]

This year, one of the Committee's priority topics was a review of ecosystem modelling undertaken outside the IWC. It first considered a review on which types of ecosystem models can best be used to address different types of ecological questions. The review concluded that (a) the choice of model depends strongly on the questions being asked, and (b) it is

[43] For a full account see JCRM 14 (suppl.), Item 12.5.
[44] For a full account see JCRM 14 (suppl.), Item 13.

usually better to start with simple multi-species models with few components, then build up to more complex models if needed. Finally, the more complex multi-species models, such as food-web models and whole-system models are more suited to address broader questions.

The Committee then considered an analysis that attempted to develop quantitative bounds on consumption estimates for marine mammals. Parameter values were taken from the literature and sensitivity and risk analyses were undertaken to develop reasonable bounds on these parameter values. This technique is particularly useful when it is not possible to collect direct information on consumption from the animals of interest.

The Committee welcomed these analyses. It noted that consumption by marine mammals warrants inclusion as a source of natural mortality in assessments of prey stocks. It also noted the challenges involved in defining concepts such as optimum sustainable production in a multispecies context. Next year, the Committee will consider ecosystem modelling and the effects on predators of fishing for forage fish and simple models of whales and prey.

The Committee also considered three somewhat conflicting papers on Antarctic minke whale body condition that led to major discussions. This followed similar discussions last year. One paper indicated there was a statistically significant decline in mean blubber thickness of Antarctic minke whales using data from JARPA. The second indicated that the JARPA data showed unlikely trends and much higher levels of variability in some parameters than would be expected, thus casting doubts on the results of the first study. The third paper used JARPA data from almost two decades and indicated a decline in energy storage in Antarctic minke whales which suggested that food availability may have been declining recently. No consensus view emerged and a number of analytical suggestions for future analyses were made as well as suggestions related to biological issues. The Committee looked forward to future analyses of these data.

18.8.2 Commission discussions and action arising

There were no discussions under this item.

18.9 Proposal for a workshop on anthropogenic impacts to cetaceans in the Arctic

18.9.1 Report of the Scientific Committee[45]

In 2010 the Commission asked the Committee to develop an agenda for a workshop on Arctic Anthropogenic Impacts on Cetaceans and in 2011 a draft agenda was completed and a steering group formed to further develop a plan for the workshop. This year a revised Agenda was presented to the Committee that focused on anthropogenic activities related to oil and gas exploration, commercial shipping and tourism. Recognising the broad complex nature of potential anthropogenic impacts to cetaceans in the Arctic, the Committee suggested that other activities such as commercial fishing and research could also be considered. Given the extent and complexity of the topic, the Committee recommended an initial scientific workshop to be followed by a workshop that addresses management and policy aspects related to Arctic anthropogenic impacts on cetaceans. It is expected that final specifications for the workshop will be developed by the workshop steering group, other IWC representatives and the Secretariat.

18.9.2 Commission discussions and action arising

The USA indicated that it was looking forward to the workshop and said that it would work with interested member Governments and members of the Scientific Committee's Environmental Concerns Working Group to help finalise the Agenda. The USA planned to work by correspondence over the next few months with a goal of holding the workshop in early 2013. Cyprus spoke on behalf of the EU member states party to the IWC to express support for the workshop and agreement with the Scientific Committee's recommendation that the workshop should address the full range of anthropogenic threats faced by Arctic cetaceans.

18.10 Reports from Contracting Governments on national and regional efforts to monitor and address the impacts of environmental change on cetaceans and other marine mammals

18.10.1 Commission discussions and action arising

The United Kingdom welcomed all the efforts being made to address cetacean environmental and health concerns. It reiterated support for the moratorium and for the UK's fundamental position against scientific whaling, now or by countries who wish to go down that road in the future. It welcomed the increasingly important work of the Conservation Committee and countries continuing to look for constructive ways to work together to address the increasing threats to all cetaceans. In particular, the UK followed with great interest the progress being made by the IWC on welfare issues, including those associated with the entanglement of large whales and marine debris, and also the on-going work on whalewatching.

[45] For a full account see JCRM 14 (suppl.), Item 12.5.3.

18.11 Health issues

18.11.1 Commission discussions and action arising

CORRESPONDENCE WITH THE WORLD HEALTH ORGANISATION

The Secretariat drew attention to document IWC/63/9 which was submitted to IWC/63 in 2011 but not discussed. It explained the steps taken by the Secretariat to reactive communication with the World Health Organisation (WHO) following a Commission request made in 2010. The information provided by the WHO showed that it had, in 2006, reaffirmed a Provisional Tolerable Weekly Intake of 1.6µg of methyl mercury per kg body weight to protect consumers of fish and other seafood. St Kitts and Nevis welcomed the Commission's intention of involving the WHO in this issue and asked for equal treatment towards the IMO on safety at sea. It believed that safety at sea should become an IWC issue with advice being given from IMO.

RESOLUTION ON THE IMPORTANCE OF CONTINUED SCIENTIFIC RESEARCH WITH REGARD TO THE IMPACT OF THE DEGRADATION OF THE MARINE ENVIRONMENT ON THE HEALTH OF CETACEANS AND RELATED HUMAN HEALTH EFFECTS

Cyprus spoke on behalf of the EU member states party to the IWC and said that the health of the oceans and marine biodiversity were negatively affected by a variety of marine pollution from various sources. Over the past years there had been mounting evidence of degradation of marine biodiversity along with potential harm to ecosystem services and functioning. In some places the increase in levels of organic contaminants, heavy metals and pathogens had taken its toll on the conservation status of cetaceans and could, in specific cases, also entail effects on human health. Cyprus noted that the IWC had already expressed concern on environmental degradation on effects on cetaceans arising from organic contaminants and heavy metals in previous Resolutions. However it believed that the time had come to revisit this issue and accordingly it had submitted a draft Resolution for the Commission's consideration (IWC/64/13).

Germany elaborated on the key elements of the Resolution by stating that the increasing levels of organic contaminants and heavy metals in the marine environment raised concerns about their impact on the health of cetaceans and their potential harm to people consuming whale meat. The last time the IWC adopted a Resolution on this important topic was more than 10 years ago[46] and since then a number of scientific studies had been published on this issue. In particular the Arctic Council's 2011 study on Arctic Pollution gave a comprehensive overview of the serious challenges to be tackled. The Resolution placed continued scientific research as a first priority and requested the Scientific Committee to remain engaged in the evaluation of the available data on organic contaminants and heavy metals in cetaceans and effects on reproduction. Secondly, the Resolution called upon Governments to take all necessary steps to implement existing legislation and standards aiming at reducing the import of contaminants including heavy metals into marine ecosystems. Finally, the Resolution appealed to the Governments concerned to remain vigilant and to inform consumers about all potential health effects related to the consumption of cetacean products.

Norway requested four small amendments to the text to clarify that the concerns regarding contaminants were related only to some rather than to all cetacean species and populations. Iceland emphasised the difference in contaminant levels between baleen whales and toothed whales. Mexico drew attention to recent studies showing that contamination is not limited to toothed whales but is found also in baleen cetaceans, for example accumulation of mercury and heavy metals in minke whales beyond levels that are tolerable to human beings. Australia requested the addition preambular paragraph reading 'Recalling also that IWC Resolution 2003-2 urges Governments to limit scientific research to non-lethal methods only'. The USA requested a change to the penultimate operative paragraph to request governments to inform consumers about both the positive and negative health effects related to consumption of cetacean products and to take actions to counter the negative effects.

Switzerland stated that the environment health issue had become a bigger concern over the years and that the consequences for human health were beyond the role of the IWC. However it invited Contracting Governments to work together to tackle problems relating to the United Nation's Framework Convention on Climate Change and as well the on-going negotiations surrounding the Convention to regulate or minimise the negative effects of mercury. Switzerland confirmed it was happy to be associated with the draft Resolution and requested the sponsors to accept co-sponsorship from Switzerland.

Norway, Switzerland, Australia, St Kitts and Nevis, the USA, Ecuador, Colombia, New Zealand, India, Brazil, Mexico, Argentina and Chile expressed support for the Resolution and the proposed amendments by Norway, the USA and Australia. Iceland, St Lucia, Japan, Palau, and Tanzania also supported the draft Resolution and amendments, with the exception of that proposed by Australia.

The Chair observed that there was widespread support for the draft Resolution and proposed to hold the item open so as to give the proponents time to take account of the requested changes. Upon returning to the discussion, Germany

[46] See Resolution 2001-10 'Resolution on the Stockholm Convention on Persistent Organic Chemicals'

confirmed that the text of the draft Resolution had been updated as follows: (1) Switzerland had been added as a cosponsor; (2) modifications had been made to the text in response to Norway's proposed amendments; (3) a preambular paragraph had been added as requested by Australia; (4) the change requested by the USA regarding both the positive and negative health effects had been made to the penultimate operative paragraph and (5) the second sentence of the penultimate operative paragraph had been proposed for deletion as it repeated the meaning of the first sentence.

Mexico and Australia said that they would have preferred the second sentence of the penultimate operative paragraph to be retained rather than deleted. Japan noted that the proposed Resolution referred to several previous Resolutions (e.g. 2003-2) which were adopted by vote rather than consensus. Noting the Chair's request that the current draft be adopted by consensus Japan requested the removal of references to previous Resolutions which had been adopted by vote.

Australia said that given the importance of the draft Resolution it did not wish to block consensus adoption. Accordingly it was willing to delete the paragraph it had proposed for addition which referred to IWC Resolution 2003-2 urging Governments to limit scientific research to non-lethal methods only. Australia stated that it attached very great importance to Resolution 2003-2 and it made the proposal to delete the paragraph only because of the importance of health effects on cetaceans and human beings. The Chair, Germany, the USA and St Kitts and Nevis thanked Australia for assisting the achievement of consensus.

St Kitts and Nevis highlighted the working of Resolution 1999-4 which requested the Secretariat to *correspond with* the World Health Organisation which led to a welcome exchange of information. However, the proposed draft Resolution requested *increased cooperation* with the WHO, which St Kitts and Nevis considered to be a different activity and that it was outside of the scope of the IWC to become involved in the affairs of another organisation. In order to ensure consistency with Resolution 1999-4 St Kitts and Nevis requested that the phrase *increased cooperation* in the first operative paragraph be changed to *increased exchange of information*.

Germany reported that the amendments discussed were acceptable to the co-sponsors of the Resolution including the additional amendments as suggested by Mexico and St Kitts and Nevis and the withdrawal of the paragraph referring to Resolution 2003-2 as proposed by Australia. With regards to these final amendments the Chair acknowledged the consensus support for the Resolution, which was adopted accordingly. The agreed text of Resolution 2012-1 is provided at Annex D.

Sandra Altherr of Pro Wildlife welcomed the proposed Resolution which summarised past discussion on contamination of cetacean products and encouraged closer cooperation with the World Health Organisation. Given recent scientific findings, Pro Wildlife said this initiative should be of high priority for all IWC members. In 2012 a scientific review of five cohort studies in the Faroe Islands indicated that consumers of all ages were exposed to serious health risks related to the consumption of contaminated cetacean products. In children impacts on reaction time, attention, memory and language were recorded where their mothers had consumed contaminated whale meat during pregnancy and breast feeding. These effects correlated with exposure to mercury and PCB levels. A follow up study documented that the effects still manifested in children seven years later. Adults were also affected as shown by cohort studies from the Faroe Islands. These showed that adults in their 70's had an increased risk to diabetes and Parkinson's disease in relation to PCB and mercury levels. In Greenland a 2004 study showed that variations in mortality were thought to be related to differences in organo-chlorine levels. Furthermore, persistent organic pollutants may contribute to sex ratio changes in the offspring of exposed populations. In Canada in 2011 new results from a study involving 300 children from all 14 Nunavik communities were published. The study directly associated mercury exposure from beluga whale meat with a 'poor intellectual function and attention in school'[47]. In 2011, the Arctic Monitoring and Assessment Program released a report on Arctic pollution which underscored that marine mammals and fish were the main source of mercury exposure for Arctic Indigenous People. The report called on health authorities to 'promote the availability and consumption of imported food items with high nutritional value and to promote consumption of traditional local foods such as fish and terrestrial mammals that have lower levels of Mercury and high nutrient value'. There were several other scientific papers which have been published over the last two years with alarming results. These findings were not limited to toothed whales as baleen whales with high contamination levels exceeding safety limits had been identified for example northern minke whales and Bryde's whales. Pro Wildlife said that the issue needed to be addressed urgently and the Resolution was therefore timely and appropriate.

18.12 Other

The Commission noted the Scientific Committee's report on Environmental and Health Issues and endorsed its recommendations.

[47] Quote taken from a video by the Nunavik Regional Board of Health and Social Services.

19. OTHER SCIENTIFIC COMMITTEE ACTIVITIES, ITS FUTURE WORK PLAN AND ADOPTION OF THE SCIENTIFIC COMMITTEE REPORT

19.1 Small cetaceans

19.1.1 Review of Ziphiids in the North Pacific Ocean and the northern Indian Ocean

REPORT OF THE SCIENTIFIC COMMITTEE

The Committee's main focus this year was a review of ziphiids in the North Pacific Ocean and the northern Indian Ocean. This was a major task and involved reviewing 10 species. Considerable valuable information was presented on biology, ecology, status and conservation issues. A number of specific scientific recommendations were made. This is not surprising given that beaked whales are difficult animals to study and so there are major information gaps for several of the species. This is reflected in the fact that eight of the species are listed as data deficient by IUCN and the Committee had no information to suggest changes to the classification.

This summary focusses on common issues and threats and on general recommendations. A well-known threat to beaked whales comes from military sonar and seismic surveys. The Committee received information on field techniques to examine stranded animals to try to establish cause of death. Provided that the animals can be examined within about 12 hours then sampling bubbles for gas composition is a valuable technique, especially for mass strandings.

The Committee also noted that there have been no atypical mass strandings of beaked whales off the Canary Islands since international military exercises ceased in 2004. This supports the inference that the atypical mass strandings reported there before that time were caused by mid-frequency sonar.

Given the evidence, the Committee strongly recommended that military exercises involving sonar and seismic surveys should avoid important beaked whale habitat and other mitigation measures should be improved. To assist in this, international collaborative efforts should be made to determine important beaked whale habitats. The Committee also reiterated two previous recommendations regarding further studies on beaked whales and noise, and the provision of advance notice of military sonar exercises and seismic surveys.

The Committee also received information on the possibility that beaked whales are especially vulnerable to marine debris. It recommended further investigation of this issue including the development of standard pathology protocols. Further information is needed to enable better assessment of status including population structure and abundance. Special attention should be paid to small and/or exploited populations.

Related to this, the Committee recommended that more efforts are made to develop methods for assessing these difficult-to-study species including the use of acoustics and improved analytical techniques for visual and acoustic surveys. Collaborative spatial modelling exercises similar to that undertaken for Mediterranean beaked whales should be undertaken in the region, to develop maps of potential critical habitat.

As for many other species, entanglement in fishing gear is an actual or potential threat to beaked whales in the region. The Committee recommended that methods be developed and applied to estimate mortality rates with special attention being given to areas where beaked whales and fishing operations overlap.

The Committee received some evidence of a decline in beaked whale abundance along the west coast of the USA that might be related to large-scale environmental change. It recommended that studies be undertaken to investigate this further.

Finally, the Committee recommended collaborative integrated studies to work further on genetics, photo-identification, acoustics and surveys.

19.1.2 Vaquita

REPORT OF THE SCIENTIFIC COMMITTEE

The Committee was extremely sorry to have to once again to stress that this species is close to extinction. It has stated this many times and made very strong recommendations but the most recent monitoring information showed that the population has continued to decline since 2008 when the abundance estimate was perhaps as few as 220 animals. This is despite the actions taken by the government to reduce fishing effort. The Committee received information that illegal fishing continues with one report of 87 boats fishing within the refuge.

The Committee strongly endorsed the report and recommendations of the International Committee for the Recovery of the Vaquita held from 20-23 February 2012 (SC/64/For Info 8). It also made two additional recommendations: one on the expedited approval and adoption of shrimp trawls as alternatives to shrimp fishing with gillnets throughout the entire range of the vaquita not just within the refuge; and a second on continued research on technologies to reduce gillnetting for finfish or otherwise to remove all gillnets from the vaquita's entire range.

To conclude, the Committee strongly reiterated its extreme concern. It reaffirmed that the only reliable approach for saving the species is to eliminate vaquita bycatch. That means removing entangling gear from all areas where the animals occur. It strongly recommended that, if extinction is to be avoided, all gillnets should be removed from the upper Gulf of California immediately.

COMMISSION DISCUSSIONS AND ACTION ARISING

The USA, supported by Argentina, Chile and Panama, commended the Government of Mexico for its past conservation initiatives on the fisheries bycatch of the vaquita. Nonetheless these countries were greatly concerned about the continuing plight of the species. Noting that the Scientific Committee had expressed its extreme concern for the status of the vaquita these countries supported continued joint efforts with Mexico to develop alternate fishing gear and alternate approaches to fishing that adequately protected a species at the brink of extinction.

Austria said that the core responsibility of the IWC was to protect whale and dolphin population species from extinction. One worst case scenario had taken place very recently; namely the extinction of the baiji in China and the IWC was on the brink of another worst case scenario in respect of the vaquita in Mexico. Austria said that that there was a need to take responsibility for species conservation, and that the responsibility would be all the greater when a highly evolved mammal species is lost forever. The Scientific Committee has communicated its concern in the strongest language they have at their disposal. Austria considered that it was time for diplomatic niceties and step wise strategies to take a back seat to immediate concrete action, with no compromise. It therefore called upon the Commission, the Secretariat, the range state and NGO's to bundle and boost their efforts on the vaquita to an entirely new higher level of urgency and resoluteness. Ecuador said that it had recognised the rights of nature in its constitution and urged support for Austria's proposals and the reduction of impacts by gillnets.

Cyprus spoke on behalf of the EU member states party to the IWC to express its deep concern about the threats to vaquita posed by gillnets. It said that bycatch is an extremely severe threat to cetaceans worldwide which is estimated to kill 300,000 whales, dolphins and porpoises each year. It congratulated Mexico for its positive stance which had included a programme to reduce the use of gillnets in vaquita habitat. Cyprus hoped to see the rapid implementation of the Scientific Committee's recommendation that all gillnets now be removed immediately. The EU had been working with Mexico on this initiative and hoped to continue doing so.

Mexico expressed its gratitude for all comments related to the vaquita and recalled that it had reported progress on this issue since 1997. It recognised that there was still much to be done to eliminate the gillnets and allow this species to recover. The goal of the comprehensive vaquita recovery programme was to protect and conserve the marine mammal and it included socio-economic and cultural considerations as well as fisheries management and monitoring concerns. Progress made so far included significant declines in illegal fishing and the rate of loss of the population had become much slower but was not yet able to bring about a recovery of the population. A working group was currently developing a process to amend the law regulating shrimp fishing with the idea being to remove gillnets from 2013 onwards. The progress made so far was due in great measure to the Scientific Committee's recommendations and also the IWC Resolution 2007-5 on vaquita. Mexico thanked the countries who continued to support work on vaquita and particularly the USA for its on-going partnership and Sweden for its assistance in the development of alternative fishing gears.

19.1.3 Eastern North Atlantic harbour porpoise

REPORT OF THE SCIENTIFIC COMMITTEE

The Committee considered the eastern North Atlantic harbour porpoise and specifically those living in the Baltic, Kattegat/Belt and North Sea areas. Results from ASCOBANS reinforce earlier concerns about the sustainability of bycatch in the region. In addition, a number of other factors potentially affecting the porpoise populations in the region, including declines in availability of prey, ship traffic, construction work, seabed exploitation, contaminants and diseases.

The Committee is especially concerned about harbour porpoises found in the Belt Sea stock where there are indications of decline. The Committee looks forward to receiving the results from a dedicated survey carried out in the summer of 2012. Bycatch is the major source of mortality and should be monitored and mitigated. Bycatch is not adequately monitored and mitigated there because the EU regulations do not apply to boats <12m. The Committee also made a number of recommendations with regard to the 'Gap' area. These relate to gaining a better understand threats and the development of appropriate mitigation measures.

Finally the Committee reiterated its longstanding concern regarding the critically endangered harbour porpoise population in the inner Baltic ('Baltic proper'). The Committee urged that effective monitoring and mitigation measures are included in national management plans.

COMMISSION DISCUSSIONS AND ACTION ARISING

There were no discussions under this Item.

19.1.4 Franciscana in Brazil

REPORT OF THE SCIENTIFIC COMMITTEE

The Committee was pleased to receive the results of a survey undertaken under the IWC's Small Cetacean Voluntary Fund of the franciscana in what is called Franciscana Management Area 1 (or FMA 1) in Brazil. The estimate for

FMA 1 was around 2,000 franciscanas with a wide confidence interval of 800-5,000. A comparison with the only available bycatch estimates from the early 2000s suggests that current bycatch may be high and unsustainable. The Committee endorsed the recommendations in the National Action Plan for the Recovery of the Franciscana developed by the relevant government agency of Brazil, as well as a number of additional recommendations.

COMMISSION DISCUSSIONS AND ACTION ARISING

Brazil said that it was concerned over the problems faced by the franciscana and had evaluated the Scientific Committee's recommendations, which it would adopt. Brazil provided a paper containing further details which had been analysed and welcomed by the Scientific Committee. Brazil thanked the IWC for the research it had undertaken and stated that it was committed to improving research and monitoring in order to reduce anthropogenic mortality.

19.1.5 River Dolphins

REPORT OF THE SCIENTIFIC COMMITTEE

The Committee has expressed great concerns over the status of river dolphins in the past. This year, it reiterated serious concerns over the population implications of the intentional killing of botos and tucuxis for use as bait in the piracatinga fishery in Brazil. This relatively new and rapidly growing problem is in addition to other historical and ongoing threats to these dolphins, e.g. from incidental mortality in fisheries, vessel traffic, hydroelectric dams, mining and other development.

In this light, the Committee recommended the organisation of an international scientific workshop involving scientists and managers from the range states. The goals of the workshop would be to address research and conservation priorities, standardise methodologies and develop long-term strategies. The status of the boto and tucuxi will be added as a recurrent item on the Committee's agenda. The Committee welcomed information that the Government of Brazil was supporting a PhD studentship to further methods of assessing river dolphins.

The Committee was pleased to hear that WWF-Pakistan had hosted a Conservation Strategy Planning Workshop in Lahore (Pakistan) during April 2012 to begin to develop a ten-year strategic action plan for the endangered Indus River Dolphin.

All freshwater populations of Irrawaddy dolphins this species are listed on the IUCN Red List as Critically Endangered. The non-calf Mekong River population is estimated at 85 individuals with recruitment close to zero. The available information, suggests a slow decline (2.2%/ per year) with serious implications for the long-term viability of the population. Last year, the Committee expressed grave concern about the rapid and at least partially unexplained decline of this riverine population. Unfortunately, the high mortality of young calves has continued as has the occasional mortality of adults from entanglement. This year, the Committee commends the Cambodian government agencies and WWF-Cambodia for making serious, concerted efforts to diagnose the cause(s) of calf mortality and further reduce the risk of entanglement. The 'Kratie Declaration' is a major step forward and the Committee recommended that it be fully implemented as quickly and as effectively as possible.

COMMISSION DISCUSSIONS AND ACTION ARISING

Brazil welcomed the Scientific Committee's recommendations regarding the boto and tucuxi and was ready to adopt them. It was particularly concerned with the new problem of these species being used for bait and said it was committed to organising the suggested international scientific workshop on these species as soon as possible.

Colombia indicated that it would act in line with the Scientific Committee's recommendations to undertake coordinated efforts with the range states to evaluate the impact of the dedicated catch of the species which were endemic to the Amazon water shed. These threats, including the use as bait, were a cross boarder problem which had been gathering strength in recent years. The results of the deliberations would be submitted to the next meeting of the Scientific Committee and Colombia asked for this topic to remain on the Commission's agenda.

China introduced information on its work to protect the Yangtze finless porpoise whose population numbers around 1,400 individuals and lives exclusively within the Yangtze river. The Government had introduced nature reserves and established protection from hunting. A number of dolphins had been removed to support breeding programmes and two or three babies had been born each year. Public awareness measures had also been introduced and China would continue to make future efforts to protect the population.

19.1.5 Central American small cetaceans

REPORT OF THE SCIENTIFIC COMMITTEE

The Committee was pleased to receive three papers on work on small cetaceans in Columbia, Venezuela and Costa Rica. Such work to establish baselines, distribution records, and habitat requirements was essential to addressing the concerns of the Committee.

COMMISSION DISCUSSIONS AND ACTION ARISING

There were no discussions under this Item.

19.1.6 Hector's dolphins

REPORT OF THE SCIENTIFIC COMMITTEE

The Committee received new information on endangered Hector's dolphins in New Zealand, where bycatch from legal and illegal fishing is a serious problem. Although the news was better for the Bank's Peninsula where there is a protected area which shows signs of improving, the Committee expressed particular concern about the low abundance of Maui's dolphins, a North Island subspecies of Hector's dolphin which may number as few as 55 animals. It recommended the immediate implementation of the proposal by the New Zealand Ministry for Primary Industries to extend the North Island protected area. This would at least protect an area with high gillnet and trawl fishing effort. The Committee also agreed that adequate observer coverage across all inshore trawl and gillnet fisheries was important in order to obtain robust scientific data on continuing bycatch as a means of assessing the effectiveness of protection measures.

COMMISSION DISCUSSIONS AND ACTION ARISING

Cyprus spoke on behalf of the EU member states party to the IWC and noted that the Maui's dolphins of New Zealand were strongly affected by gill nets. Given the extremely low numbers of Maui's dolphin recommendations to ban all gillnets from the Maui dolphin's habitat had been made by the Scientific Committee. Cyprus was interested to know what steps New Zealand intended to take to implement the recommendation and address this critical problem.

New Zealand stated that its Government and people were very concerned about the Maui dolphin population and it had reported to the Conservation Committee on the steps being taken to predict the endemic dolphins. In response to a Maui dolphin being caught in a commercial gillnet off Cape Town in January 2012, New Zealand undertook a threat management assessment process. As a result of that assessment the Department of Conservation and the Ministry for Primary Industries proposed to extend the boundaries of the existing marine mammal sanctuary and fisheries restricted area off the west coast of the North Island. In July 2012 the Ministry for Primary Industries was expected to implement the decision to extend the area banning all commercial and recreational set netting by 80 linear miles and by over 230,000 hectares. The extension of the sanctuary and fisheries restricted area meant that there will be protection for Maui's dolphins over the whole of the dolphin's known range. New Zealand considered that Protective Area Management was effective for improving marine mammal survival. In the same context it reported that the survival of Hector dolphins at Bank's Peninsular had improved by over 5% since the creation of a marine mammal sanctuary in that area.

Argentina, Chile and Sweden thanked the Government of New Zealand for its actions to protect the Hectors and Maui dolphins. Argentina recorded its support for all of the Scientific Committee's recommendations on small cetaceans.

19.1.7 Catch and bycatch information

REPORT OF THE SCIENTIFIC COMMITTEE

The Secretariat provided a summary of small cetaceans catch and bycatch in 2009-2011 from this year's national Progress Reports. The Committee is concerned that it is not doing enough to take advantage of the significant catch and bycatch information it receives and has agreed intersessionally to consider this further. It reiterated the importance of having complete and accurate catch and bycatch information and encouraged all countries to submit data, appropriately qualified and annotated. The Committee received an update on a humpback dolphin project which had found evidence of a significant bycatch problem in Congo.

COMMISSION DISCUSSIONS AND ACTION ARISING

There were no discussions under this Item.

19.1.8 Future priority topics

REPORT OF THE SCIENTIFIC COMMITTEE

The Committee had agreed that ziphiids of the Southern Hemisphere will be the priority topic at the 2013 meeting and the systematics and population structure of *Tursiops* should be the priority topic for 2014. However, in the past, the Committee has sometimes re-evaluated the priority topics based on the location of the meetings. The Committee also agreed to proceed with planning for a workshop characterised along the lines of 'poorly documented hunts of small cetaceans for food, bait or cash'.

19.1.9 Other small cetacean issues

COMMISSION DISCUSSIONS AND ACTION ARISING

South Africa thanked the Scientific Committee for its review of ziphiids and also noted that the Committee had expressed great concern regarding the conservation status of several small cetacean species and had made recommendations to mitigate impacts. South Africa endorsed all those recommendations and urged the Commission and range states to adopt and implement such measures.

Peru provided an update on the recent mortality of small cetaceans that occurred along the Northern Peruvian Coast between February and the first half of April of 2012. The Peruvian Government had investigated the event and produced a multi-disciplinary report that considered the ecological, environmental and human impacts. The main results indicated that the individuals examined showed good physical condition without evidence of injuries or clinical signs related to Brucella. The results of the molecular analysis were also negative. No internal haemorrhaging was found or alterations to the organs including the brain. Climate conditions in the region had been atypical with warm waters from the northwest, intense rainfall that led to higher than average river levels and the occurrence of an *El Niño* event along the coastline. Causes related to human activities including direct impact resulting from contamination by heavy metals and other pollutants had been discarded, and the seismic exploration undertaken in Northern Peru in 2012 was not related because the strandings began before the survey commenced. Peru had not been able to determine the exact cause but was considering the possibility of bio-toxins related to algal blooms may have played a role. It said that it would continue to investigate and would present a further report to the Scientific Committee.

Chile congratulated the Scientific Committee on its work and the growing concern for the conservation of small cetaceans. It said that this year there were many recommendations to promote further research but a lesser number of recommendations related to conservation. It said that this was uneven across the working groups and urged the Scientific Committee to also focus on conservation recommendations. Mexico supported Chile and highlighted the conservation management recommendations it had received in respect of the vaquita.

19.2 Regional non-lethal research partnerships

19.2.1 Report of the Scientific Committee[48]

The Southern Ocean Research Partnership (SORP) was originally proposed by Australia. The objective is to develop a multilateral non-lethal research programme that will provide relevant scientific information to the IWC. The partnership now involves 10 countries. The IWC has a voluntary budget associated with SORP with contributions from Australia and the USA.

Many of the recommended SORP projects have been discussed under other items and this is particularly true of the major projects related to blue whales, especially the Antarctic Blue Whale Project and the project on blue and fin whale acoustics. The Committee encouraged further international involvement in this programme, stressing the importance of standardised research protocols. The Committee was also pleased to receive updates on work on killer whales and Oceania humpback whales.

The Living Whales Symposium comprised an open symposium and four subsequent workshops that were held in Chile from 27-29 March 2012 (see SC/64/O14). Its full title was 'Living whales in the Southern Ocean: advances in methods for non-lethal cetacean research'. The workshop on health assessment recommended that health assessment data and studies should be integrated with population dynamics data, where possible; and that integration of live animal health assessment with studies on dead and stranded animals, particularly within the same geographical region, is highly informative and should be a priority. The workshop on large whale population dynamics and environmental variability looked at data and modelling/analytical approaches. It recommended that long-term studies, photo-identification and biopsy sampling be routinely used. It also promoted the use of geochemical tracers (e.g. stable isotopes) and other 'eco-markers', including DNA, since this approach can help to identify foraging locations of populations. The workshop on advances in long-term satellite tagging techniques reviewed recent advances on tag development. It recommended increased design effort to minimise/eliminate trauma of implant and water ingress. Some devices have the potential to cause considerable tissue damage and that studies on carcasses derived from incidental mortality should be conducted, as well as the monitoring of tagged animals. In addition to technical development recommendations, the workshop highlighted the need to create awareness on the use of these techniques prior to tagging project. The workshop on the estimation of diet and consumption rates highlighted several techniques that might be used to achieve this difficult objective. Understanding interspecific differences in prey preference will help to predict how climate driven changes affect krill and, ultimately whales. The need for improved knowledge of how local oceanographic conditions and prey availability affect the foraging behaviour and distribution was highlighted. The importance of better understanding of foraging strategies, prey choices and feeding destinations was also recognised.

The Committee thanked the Symposium/Workshop organisers and funders. Its value for improving current cetacean research was stressed. It may also assist with research on climate change impacts on cetaceans, e.g. Southern right whales in the southwest Atlantic, in line with wider SORP objectives.

19.2.2 Commission discussions and action arising

The USA thanked the Chair of the Scientific Committee for her presentation of the SORP and noted the growing consensus on the importance of the programme which was inter-disciplinary as well as international in scope. The USA commended Australia for its efforts and pledged to continue USA participation and support. It noted that in this budgetary environment Australia's effort was truly exceptional and should be applauded. France thanked Australia for the SORP initiative which showed that non-lethal scientific research could be constructively carried out in the Southern Ocean. It said that the French participation would be carried out from the icebreaking vessel *Astrolabe* in the Southern Ocean and the data obtained would be at the disposal of the SORP community so as to contribute to better understanding

[48] For a full account see JCRM 14 (suppl.), Item 19.

of the species, their movements and their relationship with the environment. Chile supported the work done under SORP and had actively participated in the programme. It recalled that it had hosted the Living Whales Symposium in March 2012 and thanked the Governments of the USA and Australia as well as the IWC for supporting the event. Mexico, Argentina Monaco and New Zealand all congratulated Australia on the SORP programme. Australia thanked those countries who had participated in SORP and especially thanked Chile for hosting the Symposium.

19.3 Other activities

19.3.1 Report of the Scientific Committee

19.3.1.1 STOCK IDENTITY[49]

This item deals with the technical issues related to stock definitions and population structure that face the Committee. Information on population structure is an essential part of the Committee's work and it is especially important when assessing the status of whale populations using the modelling frameworks that form the basis for the provision of conservation and management advice. This modelling forms the basis of in-depth assessments and RMP or AWMP status evaluations. These are all key to providing advice on the effects of human activities on whales, including direct hunting, bycatches in fishing gear and ship strikes.

The Committee agreed a number of recommendations concerning the methodological and technical issues related to stock definitions as well as general guidance on the presentation and interpretation of genetic data.

The Committee also discussed the progress made in updating the 'living document' that provides guidelines for ensuring sufficient quality in genetic data. This is especially important when they are used to inform the provision of conservation and management advice. The Committee is also close to completing a set of guidelines for the use and interpretation in an IWC context of some of the more common types of statistical analyses of genetic data. Both sets of guidelines will be available on the IWC webpage and published. A suite of definitions of terms like 'population', 'subpopulation', 'stock', 'sub-stock' and 'management unit' is being developed.

The Scientific Committee has also developed a software package called TOSSM which can be used to evaluate the value of specific analytical methods for setting stock boundaries. It is very important to understand scientific uncertainty in this when providing conservation and management advice. It can be used to investigate how certain observed genetic results might arise. This is important in providing conservation and management advice. For example, it was helpful in our review of the Pacific Coast Feeding Group of gray whales this year.

19.3.1.2 DNA TESTING[50]

GenBank is an important worldwide scientific database that provides as annotated collection of all publicly available DNA sequences. It contains many millions of entries. The Committee has reviewed the cetacean entries in GenBank in the past and has found some inconsistencies. It has been trying to clarify these entries but have had some difficulties contacting the relevant authors. It is investigating ways to ensure that the records are updated.

The Committee has also been reviewing DNA registers held by a number of countries. These domestic registers contain individual identification data and can be used to determine the origin of whale samples. The information is submitted voluntarily to the Committee by countries. To assist the Committee's review, it had agreed a new format for the updates of national DNA registers last year. It welcomed the fact that the updates of the DNA registers by Japan, Norway and Iceland this year were based on this new format. This facilitated greatly the annual review. The Committee also commended the analyses on quality control carried out on the Norwegian DNA register.

19.3.1.3 WORKING METHODS OF THE COMMITTEE[51]

The Committee regularly reviews its working methods and this year covered five topics.

The first topic related to ways to reduce the financial and environmental costs of meetings. This was reported to the Finance & Administration Committee and can be found under Item 21 below.

The second topic related to clarifications of the long established Data Availability Agreement (DAA). This specifically related to requests under what is termed 'Procedure B'. These are requests for data that are deemed important in providing advice to the Commission on matters other than catch limits. The full Data Availability Agreement, adopted by the Committee and Commission can be found on the IWC website. The Procedure B process has generally worked well and especially so when the Committee has been able to clearly specify the data request during the Committee meeting. The Committee reiterated the importance of clearly specifying any data requests. The Committee has always

[49] For a full account see JCRM 14 (suppl.), Item 11.
[50] For a full account see JCRM 14 (suppl.), Item 16.
[51] For a full account see JCRM 14 (suppl.), Item 24.

encouraged collaboration in research projects under the DAA but this is not mandatory. To avoid misunderstandings, the Committee recommended that an additional point to clarify this be added to the Data Availability Agreement Procedure B text.

The third topic related to updating the Committee's handbook. This follows on discussions last year, when it was agreed that the Chair of the Scientific Committee should develop a review document for consideration this year. This document focussed on whether or not there is a need to expand on the guidelines with respect to further details about the roles of Convenors and co-convenors, time frames of service and the roles of Heads of Delegation.

After a full discussion, the Committee agreed that the basic responsibilities of Convenors and co-Convenors as described in the Handbook published on the website, do not need amending. It did, however, recommend additional text to ensure that a draft prioritised list of funding projects should to be made available to the full Committee in enough time for them to review it thoroughly, as had been the case this year. It also agreed that the co-convenor concept has worked well, and it recommended additional text on the eligibility of Convenors and co-Convenors be added to the Handbook. The Committee also agreed that the existing guidelines on the selection of Convenors by the Chair are adequate and provide the necessary flexibility. It reaffirmed that the Chair should take carefully into account the length of service of Convenors when appointing them. This can be revisited in future years if necessary. The Committee also agreed that the roles of Heads of Delegations were adequately provided for in the existing Handbook. Finally, it agreed that the Handbook, when updated, should also be available as a pdf file. It will eventually contain a glossary of the many acronyms and specialist terms that are used in Committee reports.

The fourth topic related to providing assistance to new members on the working of the Committee. One of the reasons for the introduction of the Handbook was to assist new members, as well as being a reference for all. However, the Committee recognised that it can seem a complex place for new members. Therefore, it has agreed that an introductory lecture on the Committee and its methods of working will be given during the first or second day of the Scientific Committee meeting.

The fifth topic related to a suggestion by one member that suggested that while management recommendations are widely given in some sub-committees, especially when addressing whaling issues, in other sub- groups, the attention seems to be more focused on scientific recommendations with relatively few conservation recommendations. It was suggested that this be reviewed further in the context of an increased emphasis on conservation recommendations. Given the limited time available at this meeting to discuss this issue, the Committee agreed that this matter should be placed on the agenda for discussion at next year's meeting.

19.3.1.4 PUBLICATIONS

Despite staff limitations the IWC publications department produced a 520pp Supplement, 3 issues of the Journal (two are at the printers) with one more almost complete; and a special issue on Southern Hemisphere humpback whales.

The special issue on the RMP is progressing and should be available early 2013. A special volume commemorating the IDCR/SOWER cruises will be undertaken under an Editorial Board under Bannister.

The testing and trial process for a complete online submission and review process has been completed and has recently become operational.

All of the *Journal* volumes are now available as pdf files and the *Journal* will become available in that format either directly via the new IWC website or through an existing company; the Secretariat is in the process of examining the practical and financial implications of this and will report back to the Committee next year.

The Committee thanked Donovan and his team for the excellent work on publications. It reiterates the importance of these to its work as well as providing outside scientists the opportunity to benefit from the Committee's work and to encourage co-operation with the Committee.

19.3.1.5 ELECTION OF OFFICERS

This was third and last year as Chair of the Scientific Committee for Debi Palka. The Committee expressed its great appreciation for her tireless, fair and excellent work during the three-year term. It was also Toshihide Kitakado's last year as Vice-Chair and the Committee was pleased that he has agreed to take on the role of Chair at the end of the Commission Meeting. Finally the Scientific Committee Heads of Delegations unanimously nominated Dr Caterina Fortuna from Italy as Vice-chair and the Committee welcomed her acceptance.

19.3.2 Commission discussions and action arising

The Chair of the Commission was joined by the USA, Australia and Mexico in congratulating Dr Palka on the completion of her three year term as Chair of the Scientific Committee. They commended her efforts and thanked her for her excellent handling of difficult issues. The Chair wished Dr Kitakado and Dr Fortuna every success in their new roles.

19.4 Scientific Committee Future Work Plan

19.4.1 Report of the Scientific Committee[52]

The Committee developed a proposed work plan and initial draft agenda. It stressed that it is the Commission that established overall priorities and the final agenda for next year's meeting will as usual take into account Commission discussions.

19.4.2 Commission discussions and action arising

Australia noted that the Commission establishes the Committee's overall priorities and said that it did not consider the proposed intersessional expert workshop for final review of Iceland's Special Permit programme on common minke whales as a Commission priority[53]. This was particularly the case where budget allocations were limited. Special Permits were self-issued by the originating country and Australia saw no reason for the IWC to allocate significant resources to review self-issued Permits. At the very most, it suggested that some IWC funds could be used to support the core elements of the IWC implementation of the Annex P process, including perhaps support for the Scientific Committee Chair and Vice-Chair and perhaps Head of Science. Australia said that this matter had a bearing on wider budgetary issues because of the number of other calls on the Commission's budget being raised through the work of other Committees and sub-Committee's for which no provision was made in the budget. Accordingly it suggested that there was merit in including a standing item in the F&A Committee Agenda looking at the budget for intersessional work across all of the Committees, Sub-Committees including the Scientific Committee, ASW Sub-Committee, the group on Whaling Killing methods and associated welfare issues, the Conservation Committee and the Infractions sub-committee. The F&A Committee could then recommend to the Commission a budget which addressed the Committee's key priorities across the work of all its Committee's. The need to appropriately address funding of intersessional work programs was all the more important with the proposed move to biennial Meetings.

The USA understood the need to finalise the review of Iceland's scientific whaling research programme which was an agreed process by the Scientific Committee and the Commission. The review was already overdue. However, given Iceland had already concluded its research programme the review could not be considered a priority or an immediate need. The USA asked that the Government of Iceland considered supporting half the cost of the workshop or that the total cost be reduced to less than £12,000. The UK and Mexico supported the statements by USA and Australia and the UK said that priority should be given to other projects identified by the Scientific Committee. Mexico said that those who undertook unilateral whaling should pay for it.

Iceland repeated its views recorded at Agenda Item 14.2.3 that it was unable to postpone or delay the workshop because of the advanced nature of the planning and the restricted availability of the necessary scientific staff. It welcomed the USA's suggestion of reducing budget but was unable to accept the proposal because of the advanced nature of the plans.

Japan believed that the Commission should respect the Scientific Committee's proposed allocation of funding. It also highlighted that the proposed budgetary allocations had been approved and recommended in both the Budgetary Sub-Committee and the Finance and Administration Committee. Japan said that given the unanimous recommendations from both Committees there should be no need for the Commission to examine the budget.

In light of the discussions Australia, supported by Mexico and the United Kingdom proposed acceptance of the Scientific Committee's future work plan and the budget, including the £24,000 for the final review of Iceland's Special Permit whaling programme, but in doing so it recorded its view that countries who conduct unilateral self-determined whaling programmes under special permit should pay the full costs associated with any IWC reviews and that these reviews should not be paid for by the IWC. The issues had arisen because of a lack of clarity in Annex P on how reviews would be funded. Recognising upcoming future reviews Australia suggested that the Commission (through the Finance and Administration Committee) should develop guidelines for funding such reviews and these be included in Annex P. The USA accepted the proposed budget for the Scientific Committee and agreed the issue should be dealt with by the F&A Committee.

Iceland, supported by Japan and St Kitts and Nevis welcomed Australia's acceptance of the proposed budget. However these countries noted their disagreement with the view that all costs associated with the process should be borne by the

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[52] For a full account of the work programme see JCRM 14 (suppl.), Item 21.

[53] See also discussions under Agenda Item 14.2.3.

country conducting the research. The review was organised by the Scientific Committee and the total costs were therefore decided by the IWC. There was no upper limit to such costs in Annex P and so it was unreasonable that such costs should be inflicted on the research country. Iceland agreed that there should be a further discussion on this in the F&A Committee.

19.5 Adoption of the Scientific Committee's report

The Commission noted the entire report of the Scientific Committee, including its work plan and budget and endorsed any recommendations. The Chair thanked the outgoing Chair of the Scientific Committee for her considerable hard work and excellent reporting.

20. CO-OPERATION WITH OTHER ORGANISATIONS

20.1 Report of the Scientific Committee

The Committee greatly values its co-operation with other organisations. There are many matters discussed by the Committee which are of mutual interest and the exchange of ideas and observers facilitates both the IWC's work and that of other organisations. A compilation of observer's reports was available as document IWC/64/4.

20.2 Other reports

There were no other reports under this Item.

20.3 Commission discussions and action arising

DISCUSSION ON TRADE IN WHALE MEAT

Mexico supported by Argentina and Chile noted that Iceland resigned from the Commission in 1992 and re-adhered in 2002 with the reservation to paragraph 10 of the Schedule to the ICRW. It then unilaterally began commercial minke and fin whale hunting and established a reservation for whales on the CITES appendix. From 2008 it had been exporting about 2,000 tons of whale products for commercial purposes to Japan and the Faroe Islands. The hunt and export of whale meat occurred while discussions were taking place on the Future of the IWC. Mexico asked Iceland to refrain from requesting permits to export whale meat and to provide information on the level of trafficking on meat and other whale products.

Norway, supported by Iceland, Japan and Russian Federation stated that the matter of exports of whale meat was not in the remit of the IWC and instead lay with CITES. Norway noted that Iceland, Japan and Norway held a reservation on CITES appendices for minke whale meat. Therefore the trade was perfectly legal to the extent that it was going on and was also not within the remit of the IWC.

India said that it was appropriate for the IWC to co-operate with other international conventions including CITES, CMS, CBD, UNFCC, IMO so as to ensure effective functioning. India recommended that in due course it may be appropriate to develop collaboration with the UN, but that the IWC should not lose the focus of its mandate.

The Commission noted the Scientific Committee's report on collaboration with other organisations and endorsed its recommendations.

PROPOSED RESOLUTION ON HIGHLY MIGRATORY CETACEANS IN THE HIGH SEAS

Monaco referred to document IWC/64/11rev, which was a draft Resolution on highly migratory cetaceans in the high seas. Monaco explained that the Resolution addressed the fragmented legal coverage of highly migratory cetacean species in the world's oceans. The fragmented coverage arose because cetaceans travelled long distances between the high seas and waters under national jurisdiction and were protected by some countries in their domestic waters but not in others. This occurred at a time when the global community was calling for integrated marine governance. The problem was aggravated by the limited ability of the IWC to ensure compliance with its own conservation and management measures, and was further complicated by its taxonomic mandate which meant that the IWC addressed only 20% of the highly migratory cetacean species listed at Annex 1 of UNCLOS. Accordingly the Resolution was to set up effective synergies and coordination between the IWC and the relevant United Nations processes. Monaco commented that the integrated conservation of migratory cetaceans was of central importance for marine ecosystems, for the whale and dolphin watching economy and for many developing island and coastal states.

Monaco explained that the Resolution would not shift responsibility for whaling issues from the IWC to the United Nations. On the contrary it would seek synergies with UN processes by drawing the attention of a larger community of nations to the IWC's Schedule and Resolutions which would strengthen the Commission's work and embed it in the on-going initiatives at UNCLOS. Monaco commented that the remarkable progress being made by the Scientific and Conservation Committees was being undermined because some of the IWC's key decisions such as the moratorium and the Southern Ocean Sanctuary were being undermined by its own members. It commented that if the IWC continued to operate in isolation, as a restricted club with limited visibility that the situation would not be likely to improve. In drawing attention to this issue, Monaco indicated that it wished to proceed with discussion aimed at reaching consensus.

Monaco summarised the two key elements of the proposal as being: (1) the necessity to engage in determined and substantive cooperation with the UN General Assembly so as to achieve protection for cetaceans, particularly in the context of the annual negotiations for the UN Resolution on Oceans and the Law of the Sea; and (2) to examine the gaps in international legislation regarding the conservation of wholly migratory cetacean species. Monaco said it had worked to accommodate the concerns of a great many countries and expected that the text could be used as platform for discussion. It emphasised it wished to work towards gaining consensus approval of the document.

Cyprus spoke on behalf of the EU member states party to the IWC and said that the draft Resolution stressed the need to improve the functioning of the IWC and emphasised the points on which the organisation must improve its regulation of unjustified whaling practises such as so called scientific whaling sanctuaries. The draft Resolution also highlighted the lack of consideration of a significant number of species of cetaceans by the IWC. Furthermore, the migration of whales and their occurrence in several geographical areas involving coastal state waters and the high seas is something upon which the IWC should reflect. In terms of international governance, Cyprus believed that the IWC was the appropriate forum for discussions on the protection of cetaceans, including on the high seas. Contracting Governments' efforts to modernise the IWC embodied the collective will to continue discussions within the IWC. Cyprus, New Zealand, Panama, Ecuador, Costa Rica, Argentina, Mexico, Chile, USA and Brazil echoed Monaco's request that the matter be decided by consensus.

Panama believed the Resolution would lead to a better exchange of information and cooperation between the IWC and the parties and relevant organisations of the UN. Ecuador agreed with the need to improve the international framework regarding highly migratory cetaceans in the high seas, especially considering the significant number of unregulated catches and other threats. Ecuador therefore supported the proposal to strengthen coordination with the UN General Assembly and the annual Oceans Resolution. Colombia shared the need for improving compliance with decisions and the effectiveness of the IWC on issues such as the moratorium and commercial whaling. The agreements at the Rio+20 Conference had highlighted the need to strengthen international governance, in particular through greater synergy with other agreements and the United Nations. Costa Rica, Mexico, Chile and Argentina indicated their support for the Resolution. Brazil said it was appropriate to call the attention of the international community to the significant unregulated catches of highly migratory cetaceans which continued to take place and that many of those species were not included in the Schedule of the ICRW. It was therefore appropriate to seek collaboration with the UN General Assembly. India noted that close involvement between the IWC and UN Conventions was crucial to effective working and accordingly it supported the Resolution.

New Zealand said that the regulation of small cetaceans was an unresolved issue between the IWC and all other relevant bodies. This also raised the question of the relationship between the ICRW and the United Nations, and New Zealand expressed concern of bringing the divisions of the IWC into the United Nations where negotiations proceeded largely by consensus. Nonetheless the protection of small cetaceans was a serious question which was worthy of consideration in the context of the UN Oceans Resolution. The USA supported New Zealand's comments and said that highly migratory cetaceans depended on international cooperation for the conservation and management.

Norway, supported by Iceland, shared New Zealand's concerns about bringing the IWC's divisions to the General Assembly. The proposed Resolution should be seen in the light of a text which was tabled by Monaco at the UN in 2011 for inclusion in a General Assembly Resolution on Oceans and the Law of the Sea. Norway opposed that text in 2011 on the grounds that the issues regarding cetaceans and species issues in general were not a matter for the General Assembly but for the competent fisheries management organisations among which was the IWC. At that time several other countries shared Norway's position and the proposed text was not included in the UN Resolution. Norway's position had not changed and it could not therefore accept a renewed attempt at bringing cetacean management before the General Assembly. Accordingly Norway stated it would oppose a consensus.

Iceland's view was that the mandate of the IWC covered only those cetaceans listed in the Schedule to the ICRW (1946) and it noted that small cetaceans were protected by NAMMCO in its region. Iceland drew attention to the wording of the proposed Resolution which asked the IWC to regret and show deep concern for actions carried out in part by Iceland. Iceland said it would not do this and accordingly the Resolution was dishonest and it could never be a consensus agreement.

Japan considered the proposed Resolution would divide the IWC because it contained irrelevant, inconsistent and imbalanced facts. Japan provided many examples which included: (1) the title of the Resolution referring to the High Seas contrasted with the body of the Resolution which referred to efforts by coastal states; (2) the reference to Article

64 of UNCLOS, which it considered to be important for highly migratory species, was not referred to in the proposed Resolution; and (3) the first preambular paragraph on the conservation of migratory species contrasted with Article 65 of UNCLOS which described measures for exploitation and regulation of marine mammals. Japan particularly emphasized the need to refine the relationship between the wording of the proposed Resolution and Articles 61, 62, 63 and 64 of UNCLOS. Japan considered that the fifth preambular paragraph did not relate to issues concerning highly migratory cetaceans on the high seas and that the sixth paragraph referring to 'without agreed limits' was inconsistent with Article VIII of the ICRW (1946). In conclusion Japan said it had given consideration to participating in consensus but could not do so, partly because of the inconsistences and partly because it believed it was not appropriate for the IWC to give up its responsibilities and pass them to the United Nations instead.

China shared the concerns highlighted by Norway, Iceland and Japan and said that the IWC was the appropriate forum for the conservation and management of cetaceans. It said that all waters where whaling activities took place were covered by IWC including the high seas. China took into account the extensive agenda before the UN General Assembly and said that instead the members of the IWC should continue to work together to tackle such issues difficult though they may be. Because of this, China indicated it could not join consensus on the proposed Resolution.

Antigua and Barbuda considered it was inappropriate to refer IWC affairs to the General Assembly and highlighted the comments by previous speakers upon the importance of building consensus. Tanzania did not support taking IWC issues to the General Assembly and said it could not join consensus. Palau associated with these views and those of previous speakers said it could not join consensus. Grenada referred to the deep divide within the Commission regarding support for sustainable whaling and said that to bring such a Resolution to the General Assembly without consensus would transfer the divide to another organisation which did not have a mandate for the conservation and management of whales. As such Grenada could not support consensus.

Monaco expressed its gratitude for the comments made and said the intention was not to shift responsibility for whaling matters to another body, but instead to capture the interest of a large body of nations which shared the IWC's concern for migratory species. In regard to the relevance of UNCLOS Article 64 Monaco said this was concerned with fish harvesting and that Article 65 was relevant to marine mammals. Monaco considered that both the IWC and UNCLOS had unfinished business. For the IWC there was a need to understand how to deal with the species of cetaceans that were not currently addressed and how to ensure IWC management objectives were respected. In regard to UNCLOS there was a demand to continue its work on Annex 1 relating to highly migratory species. Monaco said its main objective was to build bridges between the IWC and the UN to ensure continuation of progress. Responding to Japan's concern on the use of the phrase 'without agreed limits' Monaco said that Article VIII did not provide a ceiling on catch limits and so there could be no agreement. At this point Monaco indicated it would continue to develop its proposal with a view to finding a way forwards and the Chair adjourned the debate for a short period so as to deal with other items.

Upon returning to the debate, Monaco requested to hear views from Contracting Parties on how to address the issue of small cetacean conservation, and whether it should be taken forward by UNCLOS using Annex I of the Convention which listed highly migratory species or whether the issue should be addressed at the IWC by adding about 40 species to the Schedule of the ICRW.

New Zealand commented that the earlier interventions from Japan, Norway and Iceland on how they saw the issue being dealt with confirmed the fact that there was a serious problem. New Zealand was pleased that Monaco had taken account of initial concerns by issuing a revised document, and said it was happy to continue working on this issue going forwards.

Monaco recognised the support expressed by a number of Contracting Governments and indicated it would establish, on its own initiative, a non-IWC intersessional task force to take the work forwards. The Chair thanked Monaco for its proposal and suggested that any countries interested should contact Monaco during the meeting breaks.

21. NGO ADDRESS

The Chair recalled that there had been several NGO interventions during the meeting on specific Agenda Items. These interventions had taken place after all Contracting Governments had spoken. Towards the end of the meeting it was clear that additional time had become available for NGOs to make a further address and the three separate interventions are recorded here.

Eugene Lapointe of the IWMC World Conservation Trust spoke about people in a meeting devoted to the management and conservation of whales. He had been fortunate to spend the first 12 years of his life in a wilderness where he had to provide food for his family from hunting and fishing and harvesting what nature was offering. Through this experience he had developed an understanding of the pain and anguish suffered by some peoples in the world. He said he was not happy with the outcome of the meeting because Greenland's request for ASW catch limits had been rejected. Equally he was not happy when the appeal of the four small Japanese communities had been denied once again, and he identified with the pain and felt by Greenland and Japan. Furthermore he was unhappy with the quota allocation to Russian Federation, the USA and St Vincent and The Grenadines because although they had received their quota he believed that access to food was a basic right and it was demeaning that proud people had to beg to exercise their culture and traditions. He was unhappy that human rights were ignored to the advantage of animal rights. He was unhappy when wild animals were humanised and when humans were demonised for making use of animals. In closing IWMC thanked the people of Panama for their warm hospitality and hoped that human values would recover their place in the field of international relations.

Samantha Dawes of Campaign Whale said that small cetaceans represented the vast majority of whale species. They faced many threats to their survival arising from toxic pollution, entanglement in fishing gear and large scale commercial and subsistence hunting. Sadly, these small whales now represented some of the most critically endangered species on Earth with populations and even entire species reduced to a pitiful number of animals barely clinging to existence. This year the Scientific Committee report included strong recommendations to help save the vaquita and Maui's dolphin. The Baiji was tragically already lost. Campaign Whale asked if there could be any greater focus for the IWC than to help save critically endangered species on the brink of being lost forever. At IWC/63 in 2011, 10 NGOs were able to contribute a total of £10,300 to the small cetacean voluntary fund. This year Campaign Whale and supporting organisations wished to thank Contracting Governments for their generous contributions to the same fund. The contributions allowed valuable scientific and conservation work such as developing alternative fishing gear in the vaquita's habitat. Campaign Whale recognised the increasingly important work of the Small Cetaceans Sub-committee and in particular the critical status of several small cetacean species and populations and it was pleased to announce a further donation of £11,000 to the voluntary fund for small cetaceans. This donation was made on behalf of Campaign Whale, Cetacean Society International, Humane Society International, International fund for Animal Welfare, Naturschutzbund International, Ocean Care, Whaleman Foundation, Windstar Foundation, Royal Society for the Protection of Animals and WWF International.

The Green Association of Panama represented many conservation based NGOs and was pleased to be able to speak before the close of the Meeting. It hoped that the NGO interventions that had been made had supported the debate and decision making and requested that the opportunities for NGOs to speak be implemented as permanent practice. The Green Association of Panama celebrated Commission's work on non-lethal use of cetaceans and thanked those Governments who had committed funds or actions focussing on mitigating threats to cetaceans and their habitats. Although it understood the value of consensus it also recognised that the reintroduction of the voting system was a positive influence on governance. Although the South Atlantic Sanctuary had not been established it thanked the proponents and supporters of the proposal and urged them to continue working to make the Sanctuary a reality. It thanked the Government and people of Panama and congratulated the Chair for a successful meeting.

22. ADMINISTRATIVE MATTERS

The Finance & Administration Committee met in Panama on 28 June 2012. Donna Petrachenko (Australia) chaired the meeting, which was attended by 33 Contracting Governments. A summary of the Committee's discussions is included below and the full report is available at Annex J.

22.1 Meeting arrangements and procedures

22.1.1 Need for a Technical Committee

REPORT OF THE F&A COMMITTEE

The Chair of the F&A Committee indicated that the Technical Committee had not met since IWC/51 in 1999. The question of an on-going need for a Technical Committee was an issue that the F&A Committee and then the Commission may need to address in the context of broader discussions relating to the Bureau.

COMMISSION DISCUSSIONS AND ACTION ARISING

There were no discussions under this Item.

22.1.2 Report of the Intersessional Group on Quorum

REPORT OF THE F&A COMMITTEE

The F&A Committee had considered a range of options to clarify the Commission's procedures relating to quorum and a growing consensus had developed about a proposed series of changes to Rule of Procedure B.1. In addition there was extensive discussion on the need to link suspension of voting rights to quorum, and one member had raised a question about whether quorum was necessary to adjourn a meeting.

COMMISSION DISCUSSIONS AND ACTION ARISING

New Zealand, supported by the USA recalled that the intersessional group was established because of the problems experienced at IWC/63 in 2011. The group, which was chaired by New Zealand, had made recommendations which appeared initially to have consensus support, but subsequently at the private Commissioners' meeting there were some countries that were not in favour of making changes to the rule at this stage. New Zealand was comfortable to leave the rule as it stands, if that was the preference of the membership. But it was equally supportive of making a change regarding when to apply the rule on quorum as this would be a helpful clarification. However, in New Zealand's opinion the most important outcome of the exercise had been to re-establish an understanding about how the Commission should conduct its business.

Cyprus, supported by Switzerland and Monaco, spoke on behalf of the EU member states party to the IWC to state that the principle objective on the quorum issue should be to ensure that the Commission operates under a clear set of rules to avoid behaviour that brings the Commission into disrepute. Cyprus accepted the need to determine quorum at the time decisions are taken by the Commission, but it also believed that those Contracting Governments who were not entitled to vote as a consequence of non-payment of financial contributions should logically also not count towards the number of members required to constitute a quorum.

Japan, supported by Guinea, stated that the requirement for quorum was on-going throughout the meeting but applied especially at the point of decision making. Japan also stated that suspension of voting rights did not mean suspension of membership and so a member with a suspended vote should be counted as a constituent member of the quorum.

Following discussion, the Chair noted that the rules would be left unchanged although it may be necessary to return to the discussion in the future. He also hoped that it would be possible to handle the Commission's meetings without the need for further clarification on quorum.

22.1.3 Report of the Intersessional Group on Biennial Meetings and Establishment of a Bureau

REPORT OF THE F&A COMMITTEE

The intersessional group had developed four discussion documents, one of which included a checklist of actions for moving to biennial meetings and establishing a Bureau. Within the F&A Committee there was unanimous support for moving to biennial meetings and accordingly the F&A Committee recommended that the Commission should change the frequency of its meetings to biennial, commencing with the next meeting being held in 2014. This recommendation was supported by advice from the Scientific Committee that six year blocks for Aboriginal Subsistence Whaling catch limits would be safe, and a proposal from the Budgetary Sub-committee for a two year budget. The F&A Committee recommended that the Scientific Committee would continue to meet on an annual basis in May or June and reiterated the agreement from IWC/63 in 2011 that meetings of the Scientific Committee and Commission should be separated by a period of 100 days or longer.

The F&A Committee proposed the establishment of a Bureau comprising the Chair and Vice-Chair of the Commission, the Chair of the F&A Committee and four Commissioners representing a range of views and thematic interests. The host government for the next Commission meeting and the Secretary would also attend Bureau meetings in an *ex-officio* capacity.

The Chair of the Commission would serve as the Chair of the Bureau and may call upon Chairs of the Commission's subsidiary bodies to participate in Bureau discussions as appropriate. The Bureau would not be open to observers. Its role would be to support the Commission by providing advice to the Chair and the Secretariat on on-going work programmes, especially in terms of implementing Commission decisions at times when the Commission is not in session. The Bureau will also assist in: (1) preparations for meetings of the Commission and subsidiary bodies; (2) reviewing the progress of work undertaken through Sub-committees; and (3) provision of support to the Chair during Commission Meetings. The Bureau's mandate would be to assist with process management and it would not be a decision making forum. It will not deal with substantive or policy matters under the Convention as these are reserved for the Commission. The Bureau may consider issues relating to financial or administrative tasks within the scope of the F&A Committee, but only in the context of making recommendations to that Committee.

A small group comprised of the USA, Japan and St Lucia had been tasked with finalising proposed changes to the Rules of Procedure. which were necessary to implement these recommendations.

COMMISSION DISCUSSIONS AND ACTION ARISING

Switzerland, Cyprus (on behalf of EU member states party to the IWC), the UK, Guinea, USA, Monaco, Palau, Argentina, St Kitts and Nevis and Korea thanked the intersessional group for its work and supported the proposed move to a two yearly (biennial) cycle of meetings. Cyprus considered that a more effective schedule of meetings would put the IWC on a par with other multilateral agreements and that the establishment of a Bureau was necessary to ensure the smooth progress of Commission business during the intersessional period. The UK highlighted the importance of intersessional working in advance of IWC/65 and indicated its intention to lead or participate in a number of initiatives. Guinea supported the move as it would allow the Scientific Committee to develop more detailed advice and because it would help many countries overcome their problems with arrears of payments. The USA noted that a reduced meeting frequency would provide cost savings to member governments and requested, since it was a member of the Advisory Committee, that it wished to have a seat on the Bureau. Argentina requested a seat on the Bureau for a member of the Buenos Aires Group, and St Kitts and Nevis requested a seat for the Caribbean countries. Korea highlighted the need to adjust the length of service of the Chair and Vice-Chair should the Commission move to a biennial cycle. Following these interventions the Chair of the F&A Committee confirmed that a drafting group was working to refine detailed amendments to the Rules of Procedure, and accordingly the Chair adjourned debate on this item until the drafting group's output was ready.

Upon resuming the debate, the Chair of the F&A Committee introduced the proposed changes to the Rules of Procedure and Financial Regulations and highlighted the following key items.

- The majority of the changes altered the word 'annual' to 'biennial', and these changes occurred throughout the document.
- At Rule B (Meetings) a new item 3 was proposed which read 'The Scientific Committee shall meet annually. Other Committees and sub-groups shall meet biennially prior to the meeting of the Commission. However this does not preclude intersessional work by these Committees and Sub-groups from continuing'.
- Also at Rule B (Meetings) a new item 4 was proposed which read 'The Bureau shall meet in those years in which the Commission does not meet, and shall otherwise meet as required to fulfil its functions in accordance with Rule M.9'.
- At Rule F (Chair) the length of time for the term of office of the Chair is changed to two years, and an additional sentence was added which read 'The Chair is to serve the Commission, and as such, shall serve in an individual capacity and not represent the views of their Contracting Government, when acting as Chair.' Similar changes were made to Rule G (Vice-Chair).
- At Rule M (Committees) item 9 had key changes to establish the Bureau which was proposed to comprise the Chair and Vice-Chair of the Commission, the Chair of the F&A Committee and four Commissioners representing a range of views and regional interests. Commissioners were to be appointed to the Bureau for a period of two years at biennial Commission meetings. The Commissioner for the host Government of the next meeting would serve in an *ex-officio* capacity. The Secretary would support meetings of the Bureau. The Chair of the Commission would serve as Chair of the Bureau and may call upon Chairs of the Commission's sub-groups and Committees to participate in Bureau discussions as appropriate. The changes to Rule M also included a list of Bureau roles which were to:
    - Provide advice to the Chair and Secretariat on implementing Commission decisions;
    - Assist and advise the Secretariat on administrative and financial matters between meetings of the Commission;
    - Assist in preparations for meetings of the Commission, its Sub-groups and Committees;
    - To review the progress of work by the Sub-groups and Committees;
    - To provide support to the Chair during meetings of the Commission as requested by the Chair.

The Chair of the F&A Committee concluded by stating that, if adopted, these changes would move the Commission to a biennial meeting cycle, would end the current Advisory Committee, and would establish a Bureau.

South Africa noted that the under the proposals the Bureau would comprise the Chair and Vice-Chair of the Commission, the Chair of the F&A Committee and four Commissioners representing a range of views and regional interests. South Africa was unclear how regional interest could work across four Commissioners and proposed deleting the reference to regionality. St Kitts and Nevis proposed that five Commissioners rather than four would be appropriate in order to ensure balanced representation. Norway noted that as currently drafted the Bureau was also composed of three other Commissioners (the Chair, Vice-Chair and Chair of F&A) making seven in total and this gave an opportunity to establish the requested regional balance. St Kitts and Nevis, supported by Ghana, responded that a fifth Commissioner position was necessary in order to accommodate representation from Africa. Ecuador considered it was not necessary to raise the number of members of the Bureau but requested that the phrase 'and ensuring a regionally balanced representation' should be added to the end of the second sentence of the first paragraph of Rule M.9. Monaco commented that it would be necessary to appoint the additional four or five Commissioners after the identity of the Chair, Vice-Chair and Chair of F&A had been established so as not to replicate the interests represented by these Commissioners. In addition Monaco raised the question of how to proceed if there were more Commissioners wishing to join the Bureau than places available and whether it would be necessary to have a secret ballot. South Africa clarified that it had proposed deleting the reference to regionality because of the different regions within the African continent and that one Commissioner would be unable to represent each of the regional views effectively.

Speaking in regard to the membership of the Bureau, Israel noted that the host Government for the next meeting would serve in an *ex-officio* capacity, and advised that the rule should be altered to make clear that this was in addition to the other four Commissioners already members of the Bureau. Monaco suggested that this could be achieved by redrafting the sentence to read 'In addition, the Commissioner for the host government of the next meeting of the Commission will serve in an *ex-officio* capacity for a period of two years'.

Israel drew attention to the statement which said that the role of the Bureau was to 'assist and advise the Secretariat' and suggested it was the other way around with the Secretariat assisting the Bureau. Israel suggested that the word 'assist' should be deleted and the Chair of the F&A Committee responded that this was agreeable. The Chair confirmed this was acceptable.

Chile referred to the long discussions which had taken place regarding the frequency of meetings for the Conservation Committee and requested comments on this point. The Chair of the F&A Committee responded that the proposed rule changes indicated that the Scientific Committee would continue to meet annually and the other Committees would meet intersessionally during the two year period as required. The outcomes of the preparatory discussions had made clear that all of the subsidiary bodies should be treated equally and therefore no Committee was singled out except the Scientific Committee.

Chile also asked for a list of the unresolved tasks that should be discussed before the implementation of the Bureau or which should instead be taken over by the Bureau. The Chair of the F&A Committee responded that the checklist of actions had been prepared by the Secretariat during the intersessional period and submitted to the F&A Committee (IWC/2012/IGBB1). A number of those tasks had been achieved, for example the setting of two year budgets.

St Lucia noted the existing wording of Rule of Procedure F.1 which read 'The Chair shall remain in office until a successor is elected' and requested the addition of 'if he/she agrees to do so'. The Chair indicated this change was agreeable.

Guinea requested translations into French and Spanish be provided for the Bureau meetings.

St Kitts and Nevis said that the move to biennial meetings may diminish the ability of developing countries to pay their dues because payments were often made on a basis of need or urgency, and the absence of a meeting each year may reduce the perceived need to pay. It was possible that countries would pay for both years immediately before the biennial meeting rather than on an annual basis in order to assist cash flow. Accordingly St Kitts and Nevis asked if the time limit for charging interest on unpaid contributions could be changed from 12 months (as at present) to 24 months.

St Kitts and Nevis also requested that the words 'above the base rate quoted by the Commission's bankers on the day' be deleted. St Kitts and Nevis explained that an interest rate of 2% would still provide incentive to pay without inflating it by the base rate. Switzerland, supported by Australia, recalled discussions in previous meetings where the interest rate had been lowered considerably and expressed the need for caution in reducing the rate further as it would remove the incentive to pay and may not accurately reflect interest rates. Switzerland also spoke as Chair of the Budgetary Sub-committee to state that the IWC finances were based upon receiving annual financial contributions and extending the timescale for charging interest from 12 to 24 months may create cash flow issues for the Secretariat. Switzerland urged Contracting Governments to retain the current financial arrangements as they reflected economic realities and guaranteed the smooth running of the Secretariat.

At this point the Chair again adjourned the debate to allow the drafting group to consider the changes which had been proposed. Upon re-opening the debate the Chair of the F&A Committee described the following additional changes to the proposed alterations to the Rules of Procedure and Financial Regulations, which she hoped the Commission would be able to agree to:

- The incorporation of the suggested changes to Paragraphs F and G (Chair and Vice-Chair) so that it reads 'The Chair shall, however, remain in office until a successor is elected if he/she agrees to do so'.
- At paragraph 7 of Rule M.9 in relation to the interests of the Commissioners comprising the Bureau the word regional was removed so that the Rule would read '….and four Commissioners representing a range of views and interests'.
- Also at paragraph 7 of Rule M.9 the length of service on the Bureau for the Commissioner of the next host Government was clarified by the addition of 'for a period of two years' to the end of the fourth sentence of the first paragraph.
- In relation to the functions given to the Bureau, the word 'assist' was removed from the second function so that the Rule would read 'Advise the Secretariat on administrative and financial matters…'
- With regard to Financial Regulation F.1 the drafting group proposed that interest be added to outstanding payments if that payment had not been received by the Commission within 24 months of the due date as opposed to 12 months as previously. This change was made in the recognition that funds would still be due annually and that this would ensure the effective operation of the Secretariat.

The drafting group proposed to retain the wording regarding the rate of interest to be charged as '2% above the base rate quoted by the Commission's bankers on the day.

Ecuador indicated that the changes proposed by the drafting group were acceptable but also recommended the inclusion of the words 'with a view to ensuring inclusive and balanced representation' to the end of the sentence describing the composition of the Bureau at Rule M.9. Ghana and Cote d'Ivoire asked for clarification of what was intended by the proposed use of the phrase 'views and interests' and whether it would include regional representation. The Chair of the F&A Committee clarified that the intention was to seek representation of the range of views on conservation and management of whaling held by various delegations as well as geographic interests, and that the word was removed on the understanding that the F&A Committee would be instructed to work intersessionally on the application of the meaning of regional in this context. Panama indicated its support for the proposals on the understanding that the Bureau would have a balanced membership.

St Kitts and Nevis repeated its request for the words 'above the base rate quoted by the Commission's bankers on the day' to be removed from the end of the first sentence of Financial Regulation F.1 dealing with Arrears of Contributions. St Kitts and Nevis supported by Ghana and The Republic of Guinea explained that the base rate was unpredictable and that it wished to have a greater certainty in the amounts it owed to international organisations. It commented that if the Secretariat was operating an overdraft facility and thus incurring charges because of the failure of Contracting Governments to pay dues then the charge was appropriate, but in the absence of the Secretariat operating an overdraft that the level of charge should be reduced to 2% without the addition of the base rate. St Kitts and Nevis emphasised the seriousness of the issue for developing countries.

The Chair of the F&A Committee clarified that the procedure of charging interest at 2% over the bank base rate had previously been in place prior to discussions on a biennial meeting cycle and so the current proposal did not ask Commissioners to agree to anything new in relation to the way interest was charged on arrears of contributions. New Zealand said that the rule applied at the IWC on interest charges for overdue payments was no different to the procedures used at other international organisations, and also stated that as the proposal had been raised for the first time during IWC/64 that there had not been adequate time to consider it. Cyprus noted that the unpredictably of the payments as a result of interest rate fluctuations was a result of Contracting Governments not paying on time.

St Kitts and Nevis moved that the proposal be amended so as to delete the words 'above the base rate quoted by the Commission's bankers on that date'. Accordingly, under St Kitts and Nevis' proposal the first sentence of Financial Regulation F.1 would read:

1. If a Contracting Government's annual payments have not been received by the Commission within 24 months of the due date referred to under Regulation E.2 compound interest shall be added on the anniversary of that day and each subsequent anniversary thereafter at the rate of 2%. ~~above the rate quoted by the Commission's bankers on the day.~~

The Chair thanked St Kitts and Nevis for its proposal and requested the Commission to decide on the proposal through a vote. The vote received 15 yes votes, 41 no votes and 2 abstentions. Accordingly the proposal was defeated.

Following the vote, St Kitts and Nevis and St Vincent and The Grenadines, supported by Palau, said that there was great inequality with the IWC and that it was important to ensure that developing countries were able to participate fully in the organisation's work. St Kitts and Nevis indicated that it would support the consensus adoption of the proposals as put forwards by the drafting group.

The Chair then asked if the document proposed by the drafting group could be adopted by consensus. Seeing no disagreements the document was adopted.

22.1.4 Report of the Working Group on the Role of Observers at Meetings of the Commission

REPORT OF THE F&A COMMITTEE

The Working Group on the Role of Observers had met in Panama on the 27 June (IWC/64/Rep7). There had been a wide ranging discussion which concluded with a recommendation to the private Commissioners' meeting that the total minimum time for NGO interventions was to be 30 minutes. The Working Group noted that 30 minutes over five days was a short period of time, and that primacy must be given to contracting parties. It would be at the discretion of the Chair how to use the time, or to show some additional flexibility. The Chair of the F&A Committee observed that IWC/64 had been conducted according to this guidance.

COMMISSION DISCUSSIONS AND ACTION ARISING

The USA and Mexico supported increased participation by observers, as it believed that increased transparency would give a greater legitimacy and because observers could provide a beneficial contribution to the Commission's deliberations. It noted that the process used at IWC/64 of allowing observers to speak under various agenda items after Contracting Governments and as time allows had worked very well. The USA believed this to be a positive and important step forward and it supported providing observers with greater opportunities to participate on each agenda item for which they may have input. It recommended that the IWC use this as the first step towards the ultimate goal of further increasing observer participation at future meetings in line with other inter-governmental organisations.

Cyprus spoke on behalf of the EU member states party to the IWC and was convinced that undertaking steps to improve governance would result in beneficial increases in protection and improved management practises. It would also sustain and reinforce a spirit of partnership among members as they worked to realise a common objectives. Cyprus welcomed follow up action based the experience of practises followed at IWC/64.

Colombia, Chile, Argentina, Ecuador, Uruguay and Brazil supported a greater role for observer organisations, as it would allow them to contribute knowledge and increase the transparency of the Commission. Chile, Argentina Ecuador and Uruguay highlighted the increased openness to working with NGOs within their own countries. Uruguay thanked the organisations and countries who had made voluntary contributions to the Commission's work which had reaffirmed the level of trust in the Commission. Panama, Brazil and India reiterated that the 30 minutes allowance over the five day duration should be considered a minimum and it should be expanded to the extent possible within plenary sessions. This should include expansion of the time allowance and also extension of the number of agenda items in which participation was requested. In addition Panama noted that the observers called to speak should reflect a balanced point of view which took account of regional distributions.

France, supported by Monaco, stated that NGO's participation was very important as it enriched discussions. It commented that observers had been very responsible in their contributions by respecting time limits and balancing different views. France considered the compromise at IWC/64 was a starting point for wider discussions on the participation of civil society organisations. Monaco said it would be useful to consider a substantial increase in the time of the interventions as the present system of 30 minutes allowed only between 1-2% of the total time available. Monaco suggested the figure should be a minimum of 5% so that delegations could take note of and be guided by the interventions. St Vincent and The Grenadines agreed that civil society should contribute, but noted that the system of block representation amongst Contracting Parties often gave rise to repetitious interventions which reduced the time available for NGO input. Antigua and Barbuda, supported by St Kitts and Nevis, recognised the role of civil society organisations in governance issues but considered that the existing time allocation was sufficient for the time being as the IWC was an organisation of Contracting Governments and NGOs were able to advance their agendas by working domestically within their own countries. It also highlighted the need to ensure that NGOs satisfied all domestic and international requirements for registration.

Japan shared the importance of allowing civil society participation within the time available. Priority must be given to Contracting Parties first, as it had been during the previous days discussions where one NGO was unable to speak because of time constraints. Japan also reiterated that NGO participation had to be at the discretion of the Chair so as to ensure a smooth and efficient discussion.

The Chair considered that the different NGO speakers who had taken the floor at IWC/64 had provided valuable contributions to the discussions. He said that developing NGO participation was part of an on-going process which could be moved on by a willingness to listen to discussion from both sides of the debate.

22.1.5 Report of the Working Group on Provision of Assistance to Governments of Limited Means to Participate in the Commission's work

REPORT OF THE F&A COMMITTEE

The Working Group on Provision of Assistance to Governments of Limited Means to Participate in the Commission's work had developed consensus support for the establishment of a voluntary fund. However problems continued to exist in developing agreeable wording for a Resolution which would ensure that the proposed action was compatible with Article III.5 of the Convention. The Chair of the F&A Committee reported that further work and discussions were needed to resolve this issue, and noted that the Working Group had continued to operate during IWC/64 with a view to presenting a revised proposal.

COMMISSION DISCUSSION AND ACTION ARISING

St Lucia introduced document IWC/64/18 which was a proposed Resolution on the Creation of a Fund to Strengthen the Capacity of Governments of Limited Means to Participate in the Work of the IWC. St Lucia drew attention to several other Conventions which had a similar Article to that of III.5 of the ICRW (1946) particularly the Inter-American Tropical Tuna Commission (IATTC) and the Indian Ocean Tuna Commission (IOTC). St Lucia noted that 44 of the IWC Contracting Governments were also members of either IATTC or IOTC. In recent years these Commissions had agreed consensus Resolutions which permitted the creation of specific funds to assist the full participation of developing countries, and these funds were used, *inter alia*, to permit the attendance of developing countries at Commission meetings and meetings of the Commission's subsidiary bodies. Recognising the high degree of overlapping membership between the IWC and the other conventions where such measures had been adopted, St Lucia presumed that it would be possible to seek agreement for the adoption of similar measures at the IWC.

St Lucia, Japan, Palau, Kiribati, Korea, St Vincent and The Grenadines and Tanzania supported the proposed Resolution. Japan introduced document IWC/64/19 which was information provided to facilitate discussion on the provision of assistance to Governments of limited means. It noted the similarity of the IWC's Convention with that of the IATTC and the IOTC, and drew attention to a recent IATTC meeting where the European Union had donated $50,000 to a voluntary fund to help developing countries participate at the IATTC meeting. In addition, the IOTC already operated a voluntary fund to support developing countries. Japan noted that of the 29 countries in the IWC's lowest category to pay group (Group One), ten were not present at IWC/64 in 2012 and 15 had not participated at IWC/63 in 2011. Japan noted the need for all countries to be able to attend meetings and urged support for the draft Resolution, particularly from those Contracting Governments who were also members of IATTC and IOTC. Palau said that the Resolution would: (1) achieve the objective of Resolution 2011-1; (2) recommend a procedure for disbursing funds and ensure compatibility with Article III.5 of the Convention; and (3) allow Governments of limited means to participate in the Commission's work. Kiribati emphasised that the low attendance at Commission meetings by Group One countries provided a full justification for the Commission to consider and support the proposed Resolution. Korea supported the proposed Resolution and said that as well as ensuring full participation from developing countries it would also ensure transparency on the future of the IWC.

The Russian Federation highlighted the needs of countries with transitional economies and said that CITES provided support not just for developing countries but also for countries with transitional economies. Accordingly the Russian Federation requested that the proposed Resolution be amended to include transitional economies and indicated that it would support the Resolution if this amendment could be made.

Cyprus spoke on behalf of the EU member states party to the IWC and recognised the importance of effective participation of developing country Contracting Governments in the work of the IWC. The establishment of a voluntary fund for that purpose would reflect practice under other multi-lateral agreements where the EU and its member states were strong donors. Nevertheless Cyprus stressed the need to give due regard to Article III.5 which required that the Contracting Governments pay their own costs. It considered that the wording of the article reflected the time of its drafting and would not have found its way into contemporary international treaties. Nevertheless, it was the rule in force and as such Cyprus could not support wording that would be in direct contradiction to the Convention as was the case of the fifth bullet point of the proposed Resolution. Cyprus recalled that the intersessional working group did not tackle issues related to Article III.5. However Cyprus believed that it was important for the results of projects and information to be disseminated and accordingly it suggested replacing the fifth bullet point of the Resolution with: 'Reporting at meetings of the Commission or subsidiary bodies on the above activities for which funding will be provided'. If such a change was to be made Cyprus would be pleased to support the Resolution.

Following these interventions the Chair adjourned the debate briefly to allow informal consultations. Upon resuming the debate, St Lucia reported that it had not been possible to come to an agreement but that the group had agreed to continue working intersessionally on the issue. The Chair thanked St Lucia and acknowledged that there was support for the upcoming intersessional work.

22.1.6 Review of the work of the Technical Advisor assigned to the Secretariat

REPORT OF THE F&A COMMITTEE

In 2011 the USA proposed the secondment of a Technical Advisor (David Mattila) to the Secretariat so as to progress work on reducing conflicts with cetaceans, especially relating to large whale entanglement response and reduction of ship strikes. The F&A Committee thanked Mr Mattila for his work; expressed appreciation for the progress made and thanked the USA for supporting the financial costs. The Committee noted the possibility of extending the secondment and hoped that this would be achieved.

COMMISSION DISCUSSION AND ACTION ARISING

The USA thanked Contracting Governments for their support for the secondment and indicated that they were hoping to be able to extend the duration. Mexico, Costa Rica and Argentina thanked the USA and Mr Mattila for the work achieved and expressed support for extension of the secondment dependent upon obtaining the necessary resources in the forthcoming months.

22.2 The Commission's Website

22.2.1 Report of the Finance & Administration Committee

The Chair of the F&A Committee reported that the Secretariat had introduced the pre-launch version of the new IWC website which was available for review. It had been redesigned to improve navigation and ensure clearer communication through the use of a new font and colour scheme. The website also included improved access to previous meeting documents and scanned copies of historic Annual Reports and Chair's Reports of meetings. The Secretariat indicated their intention to continue to develop the site post launch including the establishment of an international domain name address. Members of the F&A Committee were invited to provide feedback and this had included a lot of very positive responses. Some questions regarding general functioning had been discussed, and the Secretariat reported that translations had been established for 17 of the most popular pages on the old website. Proposals for further translation to address the trilingual nature of the site should be referred to the Budgetary Sub-committee.

22.2.2 Commission discussions and action arising
There were no discussions under this Item.

22.3 Operational effectiveness
22.3.1 Report of the Finance and Administration Committee
The Chair of the F&A Committee recalled that at IWC/63 the Commission adopted Resolution 2011-1 which *inter alia* resolved to include the effectiveness of operations of the IWC as a regular Item on the Commission's Agenda. The F&A Committee recognised that the move to biennial meetings would increase operational effectiveness and that other proposals for improving effectiveness linked closely to Item 2.2.4 on cost savings measures.

22.3.2 Commission discussions and action arising
Discussions under this item are recorded at Item 22.4.2.

22.4 Cost saving measures
22.4.1 Report of the Finance & Administration Committee
The F&A Committee considered document IWC/64/F&A11 which focused on reduction of freight charges and increased use of electronic documents. The Committee thanked the Secretary for efforts to reduce paper consumption and the associated move towards web based distribution of documents. It emphasised the necessity of ensuring that meeting documents distributed through the website were clearly labelled with the time and date of uploading, and for appropriate back up measures to be in place in case of failure of electronic equipment.

The F&A Committee concluded that the agenda items on operational effectiveness and cost savings measures should be combined. The USA agreed to convene an intersessional working group to take forward continued discussion on the combined item.

22.4.2 Commission discussions and action arising
Cyprus spoke on behalf of EU states party to the IWC and recalled that last year the IWC had taken some small but important steps towards the governance improvement. Noting that no organisation can or should stand still Cyprus said that a continued review of effectiveness was important to ensure consistency with current international practice. It therefore welcomed further work to review the IWC's effectiveness. The UK agreed that the move to biennial meetings would provide an opportune moment to conduct a review of IWC processes to ensure that they are fit for purpose, in line with best practice and allow the IWC to function effectively. The UK supported the continuation of intersessional work and said it would be happy to participate in the working group.

23. FORMULA FOR CALCULATING CONTRIBUTIONS AND RELATED MATTERS

23.1 Report of the Finance and Administration Committee
The Chair of the F&A Committee recalled that the interim formula for calculating contributions had been in place for a long time. This year the Budgetary Sub-committee had reviewed the issue and, based upon their recommendation, the F&A Committee agreed that the word 'interim' should be removed from the name of the measure.

23.2 Commission discussions and action arising
St Vincent and The Grenadines indicated its satisfaction that the formula for calculating contributions was now regarded as permanent rather than interim. It said that the formula was important in bringing fairness and equity to the way contributions were calculated.

24. REPORT OF THE INTERSESSIONAL CORRESPONDENCE GROUP ON STRENGTHENING IWC FINANCING

24.1 Report of the Finance and Administration Committee
The Chair of the F&A Committee referred to the report of the intersessional correspondence group, which contained a series of 11 recommendations to support the shared goal of rebuilding and maintaining healthy whale populations and to inject discipline into the way the IWC conducted its financial business. The work was intended to solve the IWC's financial constraints by accessing external funding for various purposes. Of the 11 recommendations, the first three were intended to improve accounting transparency and improve decision making. The remaining recommendations were aimed at: (1) creating the environment for fundraising; (2) establishing and eligibility and approvals process for projects; and (3) establishing a dedicated fund to receive external donations. The Chair of the F&A Committee noted that further work was necessary in order to prepare a Resolution on this subject which would be presented to the next Commission meeting.

24.2 Commission discussions and action arising
There were no discussions under this item. The Commission noted the report of the F&A Committee on this Item and endorsed its recommendations.

25. FINANCIAL STATEMENTS, BUDGETS AND OTHER MATTERS CONSIDERED BY THE BUDGETARY SUB-COMMITTEE

25.1 Review of provisional financial statement 2011/2012
25.1.1 Report of the Finance & Administration Committee
Following review by the Budgetary Sub-Committee, the Finance and Administration Committee recommended that the Commission approve the provisional financial statement and adopt it subject to audit following the close of the financial year on 31 August 2012. The F&A Committee also recommended that a standing item be added to the Budgetary Sub-Committee's agenda to report the length of time served by the Commission's auditor and to reconfirm their appointment for the following annual or biennial period as appropriate.

The F&A Committee noted that total unpaid debts now amounted to £547,000 and it recommended that the Secretary presented a review of the Financial Regulations to the next Budgetary Sub-committee meeting outlining the additional measures that could be taken to assist Contracting Governments in arrears of payments.

25.1.2 Commission discussions and action arising
There were no discussions under this Item.

25.2 Consideration of future budgets, 2012/2013 and 2013/2014
25.2.1 Report of the Finance & Administration Committee
The F&A Committee endorsed the Budgetary Sub-committee's recommendation that the future budget scenarios contained in document IWC/64/7 be adopted by the Commission, NGO observer fees to be £580 for the first observer and £285 for the second observer for the 2014 meeting.

25.2.2 Commission discussions and action arising
The Commission adopted the budget as recommended by the F&A Committee. Spain asked whether the Secretariat foresaw any possible change in the grouping of countries according to their capacity to pay and the Secretary responded that the assessment of which countries fell into each payment group would be undertaken in August prior to issue of invoices for the forthcoming year.

25.3 Other
25.3.1 Changes to the timing of the Commission's financial year
REPORT OF THE F&A COMMITTEE
The decision taken in 2011 to separate the meetings of the Scientific Committee and Commission by a period of 100 days or longer is likely to lead to a situation whereby the Commission meets in September or October 2014, which is after the close of the current financial year on 31 August. Accordingly, the F&A Committee endorsed a Budgetary Sub-committee recommendation that the Commission should change its financial year to 1 January-31 December, effective from 2015 onwards. The F&A Committee also recommended that the Secretary should continue to operate the Commission's finances at a level of expenditure consistent with the previous financial year during the two month period after the end of the agreed budget and prior to the next Commission meeting in 2014. The Secretary was asked to develop a series of options for presentation to the 2014 meeting for allowing Contracting Governments to pay the charges associated with the four month bridging period from 1 September to 31 December 2014, and that these options should include spreading the charges over future years.

COMMISSION DISCUSSIONS AND ACTION ARISING
There were no discussions under this Item.

25.3.2 Budgetary Sub-committee operations
The Chair of the F&A Committee noted that there are two open seats on the Sub-committee and urged Contracting Governments to come forwards.

COMMISSION DISCUSSIONS AND ACTION ARISING
There were no discussions under this Item.

25.3.3 Recommendation from the ASW Sub-committee
The F&A Committee noted a recommendation from the ASW Sub-committee to consider establishing a voluntary fund at the next Commission meeting to support work associated with the management of aboriginal subsistence whaling. There are a number of funds currently operating for a range of issues including small cetaceans, conservation management plans etc and therefore this proposal would create and additional, separate fund.

COMMISSION DISCUSSIONS AND ACTION ARISING

There were no discussions under this Item.

25.3.4 Voluntary fund for Conservation Management Plans

The Chair of the Conservation Committee drew attention to the guidelines agreed by the Conservation Committee for allocating money from the voluntary fund for Conservation Management Plans. Consistent with these guidelines the Conservation Committee recommended the approval of funding for the period 2011-2013 of up to £50,000 for the South West Atlantic Southern Right Whale CMP and £25,000 for the Western Gray Whale CMP. The Committee had been advised that no funding support was required for the Eastern South Pacific Right Whale CMP at the current time.

COMMISSION DISCUSSIONS AND ACTION ARISING

There were no discussions under this Item.

26. ADOPTION OF THE REPORT OF THE FINANCE AND ADMINISTRATION COMMITTEE

26.1 Chair of the F&A Committee

The Commission elected, by consensus, Ms Donna Petrachenko (Australia) for a second three year term as Chair of the F&A Committee.

26.2 Adoption of the Finance and Administration Committee report

The Commission adopted the report of the F&A Committee and endorsed all recommendations.

27. DATE AND PLACE OF FORTHCOMING MEETINGS

The Commission accepted an offer from Government of the Republic of Korea to host the Scientific Committee meeting in 2013. There were no offers to host the Scientific Committee meeting in 2014 or the Commission meeting in 2014.

28. BUREAU

Following agreement under Agenda Item 22.1.3, the Advisory Committee was disbanded and replaced by the Bureau. The Commissioners from the USA, Panama, Ghana and Japan were elected by consensus to the four open seats on the Bureau. Thus the membership of the Bureau comprised the Chair (St Lucia), the Vice-Chair (Belgium), the Chair of the F&A Committee (Australia) and the USA, Panama, Ghana and Japan.

29. SUMMARY OF DECISIONS AND REQUIRED ACTIONS

The Chair noted that the Secretariat had posted press releases on the IWC website at the end of each day of the Plenary. In addition, a Status of the Agenda document showing decisions taken under each item and associated voting records was available for download from the IWC/64 documents website. A comprehensive summary of decisions and required actions is provided at the beginning of this report.

30. OTHER MATTERS

The meeting closed at 17.50 on 6 July 2012.

LIST OF ANNEXES

Annex A	Delegates and Observers Attending the 64th Annual Meeting
Annex B	Agenda for the 64th Annual Meeting
Annex C	List of Documents
Annex D	Resolutions Adopted at the 64th Annual Meeting
Annex E	Report of the Sub-committee on Aboriginal Subsistence Whaling
Annex F	Report of the Conservation Committee
Annex G	Report of the Working Group on Whale Killing Methods and Associated Welfare Issues
Annex H	Report of the Infractions Sub-committee
Annex I	Catches by IWC Member Nations in the 2011 and 2011/2012 Seasons

Annex J	Report of the Finance and Administration Committee
Annex K	Report of the Working Group on the role of Observers
Annex L	Approved Budget for the two year period 2012-2013 and 2013-2014.
Annex M	Approved Research Budget for 2012/2013
Annex N	Amendments to the Schedule Adopted at the 64th Annual Meeting

U.S. PACIFIC DRAFT MARINE MAMMAL STOCK ASSESSMENTS: 2018

James V. Carretta[1], Karin. A. Forney[3], Erin M. Oleson[2], David W. Weller[1], Aimee R. Lang[9], Jason Baker[2], Marcia M. Muto[4] , Brad Hanson[5], Anthony J. Orr[4], Harriet Huber[4], Mark S. Lowry[1], Jay Barlow[1], Jeffrey E. Moore[1], Deanna Lynch[6], Lilian Carswell[7], and Robert L. Brownell Jr.[8]

NOAA-TM-NMFS-SWFSC-XXX
U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

1 - NOAA Fisheries, Southwest Fisheries Science Center, 8901 La Jolla Shores Drive, La Jolla, CA 92037.
2 - NOAA Fisheries, Pacific Islands Fisheries Science Center, 1845 Wasp Blvd., Building 176, Honolulu, HI 96818.
3 - NOAA Fisheries, Southwest Fisheries Science Center, 110 Shaffer Road, Santa Cruz, CA 95060.
4 - NOAA Fisheries, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.
5 - NOAA Fisheries, Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle WA 98112.
6 - U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office, 510 Desmond Drive SE, Suite 102, Lacey, WA 98503.
7 - U.S. Fish and Wildlife Service, 2493 Portola Road, Suite B, Ventura, California, 93003
8 - NOAA Fisheries, Southwest Fisheries Science Center, 34500 Highway 1, Monterey, Ca 93940.
9 – Ocean Associates Inc., under contract to Southwest Fisheries Science Center, 8901 La Jolla Shores Drive, La Jolla, CA 92037.

Stock assessment reports and appendices revised in 2018. Previous editions of stock assessments for other stocks and years can be found at the NOAA Marine Mammal Stock Assessment page.

PINNIPEDS

CETACEANS - U.S. WEST COAST

CETACEANS – HAWAII & WESTERN PACIFIC

APPENDICES

PREFACE

Under the 1994 amendments to the Marine Mammal Protection Act (MMPA), the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) are required to publish Stock Assessment Reports for all stocks of marine mammals within U.S. waters, to review new information every year for strategic stocks and every three years for non-strategic stocks, and to update the stock assessment reports when significant new information becomes available. Pacific region stock assessments include those studied by the Southwest Fisheries Science Center (SWFSC, La Jolla, CA), the Pacific Islands Fisheries Science Center (PIFSC, Honolulu, HI), the National Marine Mammal Laboratory (NMML, Seattle, WA), and the Northwest Fisheries Science Center (NWFSC, Seattle, WA). The 2018 Pacific marine mammal stock assessments include revised reports for 16 Pacific marine mammal stocks under NMFS jurisdiction, including 7 "strategic" stocks: Hawaiian monk seal, Eastern North Pacific blue whale, Western North Pacific gray whale, California/Oregon/Washington humpback whale, California/Oregon/Washington fin whale, Eastern North Pacific sei whale and Southern Resident killer whale. New abundance estimates are available for 8 stocks: California sea lions, Hawaiian monk seals, Eastern North Pacific Offshore killer whales, Southern Resident killer whales, Eastern North Pacific gray whales, Western North Pacific gray whales, California/Oregon/Washington humpback whales, and Hawaii Island spinner dolphins. A new population assessment for California sea lions estimates that the population size was approximately 258,000 animals in 2014 (Laake et al. 2018). The stock is estimated to be approximately 40% above its maximum net productivity level (MNPL = 183,481 animals), and it is therefore considered within the range of its optimum sustainable population (OSP) (Laake et al. 2018). The California sea lion population's carrying capacity was estimated at approximately 275,000 animals in 2014 (Laake et al. 2018).

New information on human-caused sources of mortality and serious injury is included for those stocks where new data are available or resulted in a significant change compared with previously-documented levels of anthropogenic mortality and injury. In particular, new information on serious injury and mortality resulting from estimated vessel strikes is included for the following stocks of large whales: California/Oregon/Washington humpback whale, California/Oregon/Washington fin whale, and the Eastern North Pacific blue whales, based on an analysis by Rockwood *et al*. 2017. Estimated levels of vessel strike mortality exceed PBR for both blue and humpback whale stocks, although estimated vessel strike levels represent a small fraction of the overall estimated population sizes

(0.5% to <2%). Estimated vessel strikes are also compared with recent detected levels of vessel strikes, which indicate that detection rates for vessel strike events are quite low, generally less than 15%.

For large whale stocks, previous cases of unidentified whale entanglements have been assigned to species based on an assignment model generated from historic known-species entanglements in the region (Carretta 2018). This has eliminated one negative bias in assessments that occurs when unidentified whale entanglements are not assigned to any species/stock.

This is a working document and individual stock assessment reports will be updated as new information on marine mammal stocks and fisheries becomes available. Background information and guidelines for preparing stock assessment reports are reviewed in Wade and Angliss (1997). The authors solicit any new information or comments which would improve future stock assessment reports.

Draft versions of the 2018 stock assessment reports were reviewed by the Pacific Scientific Review Group at the March 2018 meeting.

These Stock Assessment Reports summarize information from a wide range of original data sources and an extensive bibliography of all sources is given in each report. We recommend users of this document refer to and cite *original* literature sources cited within the stock assessment reports rather than citing this report or previous Stock Assessment Reports.

References:

Carretta, J.V. 2018. A machine-learning approach to assign species to 'unidentified' entangled whales. Endangered Species Research Vol. 36: 89–98.

Rockwood C.R., J. Calambokidis, and J. Jahncke. 2017. High mortality of blue, humpback and fin whales from modeling of vessel collisions on the U.S. West Coast suggests population impacts and insufficient protection. PLoS ONE 12(8): e0183052.

Laake, J.L., M.S. Lowry, R.L. DeLong, S.R. Melin, and J.V. Carretta. 2018. Population growth and status of California sea lions. The Journal of Wildlife Management, DOI: 10.1002/jwmg.21405.

Wade, P.R. and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. NOAA Technical Memorandum NMFS-OPR-12. Available from Office of Protected Resources, National Marine Fisheries Service, Silver Spring, MD. 93p.

Revised ~~7/31/2015~~ 9/4/2018

GRAY WHALE (*Eschrichtius robustus*): Eastern North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Once common throughout the Northern Hemisphere, the gray whale was extinct in the Atlantic by the early 1700s (Fraser 1970; Mead and Mitchell 1984), ~~though one~~but anomalous sightings occurred in the Mediterranean Sea in 2010 (Scheinin *et al.* 2011) and another off Namibia in 2013 (Elwen and Gridley 2013). Gray whales are now only commonly found in the North Pacific. Genetic comparisons indicate there are distinct “Eastern North Pacific” (ENP) and “Western North Pacific” (WNP) population stocks, with differentiation in both mtDNA haplotype and microsatellite allele frequencies (LeDuc *et al.* 2002; Lang *et al*. 2011a; Weller *et al*. 2013).

Figure 1. Approximate distribution of the Eastern North Pacific stock of gray whales (shaded area).

During summer and fall, most whales in the ENP population feed in the Chukchi, Beaufort and northwestern Bering Seas (Fig. 1). An exception ~~to this is the relatively small number of whales (~~are approximately 200~~)~~ whales that summer and feed along the Pacific coast between Kodiak Island, Alaska and northern California (Darling 1984, Gosho *et al.* 2011, Calambokidis *et al.* 2012), referred to as the “Pacific Coast Feeding Group” (PCFG). Three primary wintering lagoons in Baja California, Mexico are utilized, and some females are known to make repeated returns to specific lagoons (Jones 1990). Genetic substructure on the wintering grounds is indicated by significant differences in mtDNA haplotype frequencies between females (mothers with calves) using two of the primary calving lagoons and females sampled in other areas (Goerlitz *et al*. 2003). Other research identified a small, but significant departure from panmixia between two of the lagoons using nuclear data, although no significant differences were identified using mtDNA (Alter *et al.* 2009).

Tagging, photo-identification and genetic studies show that some whales identified in the WNP off Russia have been observed in the ENP, including coastal waters of Canada, the U.S. and Mexico (Lang 2010; Mate et al. 2011; Weller *et al*. 2012; Urbán *et al*. 2013, Mate *et al*. 2015). In combination, these studies have recorded a total of 27 gray whales observed in both the WNP and ENP. Despite this overlap, significant mtDNA and nDNA differences are found between whales in the WNP and those summering in the ENP (Lang *et al*. 2011a).

In 2010, the IWC Standing Working Group on Aboriginal Whaling Management Procedure noted that different names had been used to refer to gray whales feeding along the Pacific coast, and agreed to designate animals that spend the summer and autumn feeding in coastal waters of the Pacific coast of North America from California to southeast Alaska as the “Pacific Coast Feeding Group” or PCFG (IWC 2012). This definition was further refined for purposes of abundance estimation, limiting the geographic range to the area from northern California to northern British Columbia (from 41°N to 52°N), limiting the temporal range to the period from June 1 to November 30, and counting only those whales seen in more than one year within this geographic and temporal range (IWC 2012). The IWC adopted this definition in 2011, but noted that “not all whales seen within the PCFG area at this time will be PCFG whales and some PCFG whales will be found outside of the PCFG area at various times during the year.” (IWC 2012).

Photo-identification studies between northern California and northern British Columbia provide data on the abundance and population structure of PCFG whales (Calambokidis *et al*. 2012). Gray whales using the study area in summer and autumn include two components: **1)** whales that frequently return to the area, display a high degree of intra-seasonal “fidelity” and account for a majority of the sightings between 1 June and 30 November. Despite movement and interchange among sub-regions of the study area, some whales are more likely to return to the same sub-region where they were observed in previous years; **2)**“visitors” from the northbound migration that are sighted only in one year, tend to be seen for shorter time periods in that year, and are encountered in more limited areas. Photo-identification (Gosho *et al*. 2011; Calambokidis *et al*. 2012) and satellite tagging (Mate *et al*. 2010; Ford *et al*. 2012) studies have documented some PCFG whales off Kodiak Island, the Gulf of Alaska and Barrow, Alaska, well to the north of the pre-defined 41°N to 52°N boundaries used in some PCFG-related analyses (e.g. abundance estimation).

Frasier *et al.* (2011) found significant differences in mtDNA haplotype distributions between PCFG and ENP gray whale sequences, in addition to differences in long-term effective population size, and concluded that the PCFG qualifies as a separate management unit under the criteria of Moritz (1994) and Palsbøll *et al.* (2007). The authors noted that PCFG whales probably mate with the rest of the ENP population and that their findings were the result of maternally-directed site fidelity of whales to different feeding grounds.

Lang *et al.* (2011b) assessed stock structure of ENP whales from different feeding grounds using both mtDNA and eight microsatellite markers. Significant mtDNA differentiation was found when samples from individuals (n=71) sighted over two or more years within the seasonal range of the PCFG were compared to samples from whales feeding north of the Aleutians (n=103), and when PCFG samples were compared to samples collected off Chukotka, Russia (n=71). No significant differences were found when these same comparisons were made using microsatellite data. The authors concluded that (1) the significant differences in mtDNA haplotype frequencies between the PCFG and whales sampled in northern areas indicates that use of some feeding areas is being influenced by internal recruitment (e.g., matrilineal fidelity), and (2) the lack of significance in nuclear comparisons suggests that individuals from different feeding grounds may interbreed. The level of mtDNA differentiation identified, while statistically significant, was low and the mtDNA haplotype diversity found within the PCFG was similar to that found in the northern strata. Lang *et al*. (2011b) suggested this could indicate recent colonization of the PCFG but could also be consistent with external recruitment into the PCFG. An additional comparison of whales sampled off Vancouver Island, British Columbia (representing the PCFG) and whales sampled at the calving lagoon at San Ignacio also found no significant differences in microsatellite allele frequencies, providing further support for interbreeding between the PCFG and the rest of the ENP stock (D'Intino *et al*. 2012). Lang and Martien (2012) investigated potential immigration levels into the PCFG using simulations and produced results consistent with the empirical (mtDNA) analyses of Lang et al. (2011b). Simulations indicated that immigration of >1 and <10 animals per year into the PCFG was plausible, and that annual immigration of 4 animals/year produced results most consistent with the empirical study.

While the PCFG is recognized as a distinct feeding aggregation (Calambokidis et al. 2012; Mate et al. 2010; Frasier et al. 2011; Lang *et al*. 2011b; IWC 2012), the status of the PCFG as a population stock remains unresolved (Weller *et al*. 2013). A NMFS gray whale stock identification workshop held in 2012 included a review of available photo-identification, genetic, and satellite tag data. The report of the workshop states "there remains a substantial level of uncertainty in the strength of the lines of evidence supporting demographic independence of the PCFG." (Weller *et al*. 2013). The NMFS task force, charged with evaluating stock status of the PCFG, noted that "both the photo-identification and genetics data indicate that the levels of internal versus external recruitment are comparable, but these are not quantified well enough to determine if the population dynamics of the PCFG are more a consequence of births and deaths within the group (internal dynamics) rather than related to immigration and/or emigration (external dynamics)." Further, given the lack of significant differences found in nuclear DNA markers between PCFG whales and other ENP whales, the task force found no evidence to suggest that PCFG whales breed exclusively or primarily with each other, but interbreed with ENP whales, including potentially other PCFG whales. Additional research is needed to better identify recruitment levels into the PCFG and further assess the stock status of PCFG whales (Weller et al. 2013). In contrast, the task force noted that WNP gray whales should be recognized as a population stock under the MMPA, and NMFS prepared a separate report for WNP gray whales in 2014. Because the PCFG appears to be a distinct feeding aggregation and may warrant consideration as a distinct stock in the future, separate PBRs are calculated for the PCFG to assess whether levels of human-caused mortality are likely to cause local depletion.

POPULATION SIZE

Systematic counts of gray whales migrating south along the central California coast have been conducted by shore-based observers at Granite Canyon most years since 1967 (Fig. 2). The most recent estimate of abundance for the ENP population is from the ~~2010/2011~~2015/2016 southbound survey and is 26,960 (CV=0.05) ~~20,990 (CV=0.05)~~ whales (Durban *et al*. ~~2013~~2017) (Fig. 2).

Photographic mark-recapture abundance estimates for PCFG gray whales between 1998 and ~~2012~~2015, including estimates for a number of smaller geographic areas within the IWC-defined PCFG region (41°N to 52°N), are reported in Calambokidis *et al*. (~~2014~~2017). The ~~2012~~ 2015 abundance estimate for the defined range of the PCFG between 41°N to 52°N is ~~209~~ 243 whales (SE=~~15.4~~18.9; CV= ~~0.07~~0.08).

Eastern North Pacific gray whales experienced an unusual mortality event (UME) in 1999 and 2000, when large numbers of emaciated animals stranded along the west coast of North America (Moore *et al*., 2001; Gulland *et al*., 2005). Over 60% of the dead whales were adults, compared with previous years when calf strandings were more common. Several factors following this UME suggest that the high mortality rate observed was a short-term, acute event and not a chronic situation or trend: 1) in 2001 and 2002, strandings decreased to levels below UME levels (Gulland *et al*., 2005); 2) average calf production returned to levels seen before 1999; and 3) in 2001, living whales no longer appeared emaciated. Oceanographic factors that limited food availability for gray whales were identified as likely causes of the UME (LeBouef et al. 2000; Moore et al. 2001; Minobe 2002; Gulland et al. 2005), with resulting declines in survival rates of adults during this period (Punt and Wade 2012). The population has recovered to levels seen prior to the UME of 1999-2000 and the current estimate of abundance is the highest that has been recorded in the 1967-2015 time series (Fig. 2).

~~Gray whale calves have been counted from Piedras Blancas, a shore site in central California, in 1980-81 (Poole 1984a) and each year from 1994 to 2012 (Perryman *et al*. 2002; Perryman and Weller 2012). In 1980 and 1981, calves comprised 4.7% to 5.2% of the population (Poole 1984b). Calf production indices, as calculated by dividing northbound calf estimates by estimates of population abundance (Laake *et al*. 2012), ranged between 1.3 - 8.8% (mean=4.2%) during 1994-2012. Annual indices of calf production include impacts of early postnatal mortality but may overestimate recruitment because they exclude possibly significant levels of killer whale predation on gray whale calves north of the survey site (Barrett-Lennard et al. 2011). The relatively low reproductive output reported is consistent with little or no population growth over the time period (Laake *et al*. 2012; Punt and Wade 2012).~~

Minimum Population Estimate

The minimum population estimate (N_{MIN}) for the ENP stock is calculated from Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the ~~2010/11~~2015/2016 abundance estimate of ~~20,990~~ 26,960 and its associated CV of 0.05 (Durban et al. 2013), N_{MIN} for this stock is ~~20,125~~ 25,849.

The minimum population estimate for PCFG gray whales is calculated as the lower 20th percentile of the log-normal distribution of the ~~2012~~ 2015 mark-recapture estimate of ~~209~~ 243 (CV=~~0.07~~0.08), or ~~197~~ 227 animals.

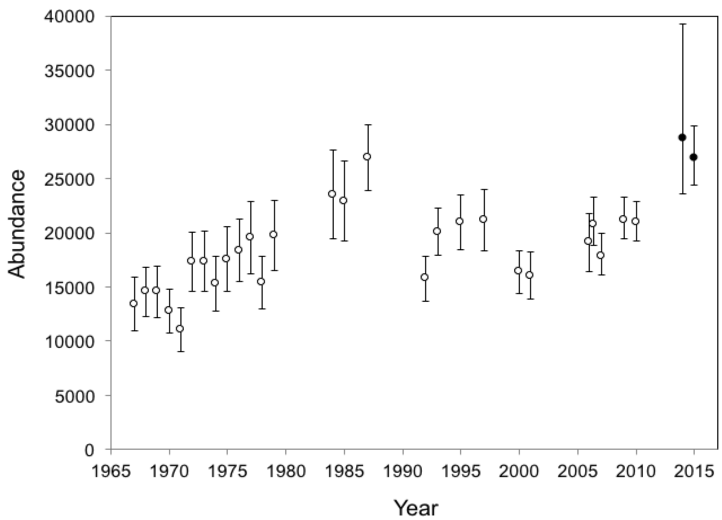

Figure 2. Estimated abundance of Eastern North Pacific gray whales from NMFS counts of migrating whales past Granite Canyon, California. Open circles represent abundance estimates and 95% confidence intervals reported by Laake *et al*. (2012) and Durban *et al*. (2015). Closed circles represent estimates and 95% posterior highest density intervals reported by Durban et al. (~~2013~~2017) for the ~~2006/7, 2007/8, 2009/10, and 2010/11~~ 2014/2015 and 2015/2016 migration seasons.

Current Population Trend

The population size of the ENP gray whale stock has increased over several decades despite an UME in 1999 and 2000 ~~and has been relatively stable since the mid-1990s~~ (see Fig. 2). Durban *et al*. (2017) noted that a recent 22% increase in ENP gray whale abundance over 2010/2011 levels is consistent with high observed and estimated calf production (Perryman *et al.* 2017). Recent increases in abundance also support hypotheses that gray whales may experience more favorable feeding conditions in arctic waters due to an increase in ice-free habitat that might result in increased primary productivity in the region (Perryman *et al*. 2002, Moore 2016). Abundance estimates of PCFG whales increased from 1998 through 2004, remained stable for the period 2005-2010, and have steadily increased during the 2011-2015 time period (Calambokidis *et al.* 2017). ~~Abundance estimates of PCFG gray whales reported by Calambokidis et al. (2014) show a high rate of increase in the late 1990s and early 2000s, but have been relatively stable since 2003.~~

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Using abundance data through 2006/07, an analysis of the ENP gray whale population led to an estimate of Rmax of 0.062, with a 90% probability the value was between 0.032 and 0.088 (Punt and Wade 2012). This value of

Rmax is also applied to PCFG gray whales, as it is currently the best estimate of Rmax available for gray whales in the ENP.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the ENP stock of gray whales is calculated as the minimum population size (~~20,125~~ 25,849), times one-half of the maximum theoretical net population growth rate (½ x 6.2% = 3.1%), times a recovery factor of 1.0 for a stock above MNPL (Punt and Wade 2012), or ~~624~~ 801 animals per year.

The potential biological removal (PBR) level for PCFG gray whales is calculated as the minimum population size (~~197~~ 227 animals), times one half the maximum theoretical net population growth rate (½ x 6.2% = 3.1%), times a recovery factor of 0.5 (for a population of unknown status), resulting in a PBR of ~~3.1~~ 3.5 animals per year. Use of the recovery factor of 0.5 for PCFG gray whales, rather than 1.0 used for ENP gray whales, is based on uncertainty regarding stock structure (Weller *et al*. 2013) and guidelines for preparing marine mammal stock assessments which state that “Recovery factors of 1.0 for stocks of unknown status should be reserved for cases where there is assurance that N_{min}, R_{max}, and the kill are unbiased and where the stock structure is unequivocal” (NMFS 2005). Given uncertainties in the levels of external versus internal recruitment of PCFG whales described above, the equivocal nature of the stock structure, and the small estimated population size of the PCFG, NMFS will continue to use the default recovery factor of 0.5 for PCFG gray whales.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

~~No gray whales were observed entangled in California gillnet fisheries between 2008 and 2012 (Carretta and Enriquez 2009, 2010, 2012a, 2012b, Carretta et al., 2014a.), but previous mortality in the swordfish drift gillnet fishery has been observed (Carretta et al. 2004) and there have been recent sightings of free-swimming gray whales entangled in gillnets (Table 1).~~ The California large-mesh drift gillnet fishery for swordfish and thresher shark includes 4 observed entanglement records of gray whales from 8,845 observed fishing sets over the 27-year period 1990-2016 (Carretta *et al*. 2018a). The estimated bycatch of gray whales in this fishery for the most recent 5-year period is 2.1 (CV=0.76) whales, or 0.4 whales annually (Carretta *et al.* 2018a). By comparison, the more coastal set gillnet fishery for halibut and white seabass has no observations of gray whale entanglements from over 10,000 observed sets for the same time period. This compares with 11 opportunistically documented gillnet entanglements of gray whales in U.S. west coast waters during the most recent 5 year period of 2012-2016, including one self-report from a set gillnet vessel operator (Carretta *et al.* 2018b). The origin of the gillnet gear for the remaining 10 entanglements is unknown. Alaska gillnet fisheries also interact with gray whales, but these fisheries largely lack observer programs~~, including those in Bristol Bay known to interact with gray whales~~. Some gillnet entanglements involving gray whales along the coasts of Washington, Oregon, and California may involve gear set in Alaska and/or Mexican waters and carried south and/or north during the annual migration.

Table 1. Entanglement mortality and serious injury of gray whales, 2012-2016 (Carretta *et al.* 2018a, 2018b). Fractional bycatch estimates in swordfish drift gillnets during 2014-2016 result from a model that incorporates all years of observer data for bycatch prediction, thus bycatch estimates can be positive even when no bycatch is observed. Entanglement in other fisheries is derived from strandings and at-sea sightings of entangled whales and thus represent minimum impacts because they are opportunistically documented (Carretta *et al.* 2018b). Mortality and injury information, where possible, is assigned to either the ENP gray whale stock or PCFG whales.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed mortality (+ serious injury)	Estimated mortality (CV)	Mean annual takes 2012-2016 (CV)
CA/OR thresher shark/swordfish drift gillnet	2012 2013 2014 2015 2016 2012-2016	observer	19% 37% 24% 20% 18% 23%	0 (0) 1 (0) 0 (0) 0 (0) 0 (0) ENP 1 (0)	0 (n/a) 1 (n/a) 0.1 (5.9) 0.7 (2.1) 0.5 (2.4) 2.1 (0.76)	0.4 (0.76) (ENP stock)
CA halibut and white seabass set gillnet	2012-2016	vessel self-report	n/a	ENP 0 (0.75)	n/a	ENP 0.15 (n/a)
CA Dungeness crab pot	2012-2016	strandings + sightings	n/a	ENP 1 (1.75) PCFG 1 (0)	n/a	ENP 0.55 (n/a) PCFG 0.2 (n/a)
OR Dungeness crab pot	2012-2016	strandings + sightings	n/a	ENP 0 (0.75)	n/a	ENP 0.15 (n/a)

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed mortality (+ serious injury)	Estimated mortality (CV)	Mean annual takes 2012-2016 (CV)
Cod pot fishery				ENP 0 (0.75)		ENP 0.15 (n/a)
Unidentified pot/trap fishery				ENP 1 (7.25) PCFG 0 (1.5)		ENP 1.6 (n/a) PCFG 0.3 (n/a)
Unidentified gillnet fishery				ENP 3 (5.5)		ENP 1.7 (n/a)
Unidentified fishery interactions				ENP 2 (12) PCFG 0 (1)		ENP 2.8 (n/a) PCFG 0.2 (n/a)
Marine debris entanglement				ENP 1 (0.75)		ENP 0.35 (n/a)
Tribal crab pot gear	2012-2016	self-report	n/a	PCFG 0 (0.75)		PCFG 0.15 (n/a)
Totals				ENP 9.1 (29.5) PCFG 1 (3.25)		ENP 7.9 (n/a) PCFG 0.85 (n/a)

Entanglement in commercial pot and trap fisheries along the U.S. west coast is another source of gray whale mortality and serious injury (Carretta *et al*. 2018b). Most data on human-caused mortality and serious injury of gray whales are from strandings, including at-sea reports of entangled animals alive or dead (Carretta et al. ~~2013, 2014b~~ 2018b). Strandings represent only a fraction of actual gray whale deaths (natural or human-caused), as reported by Punt and Wade (2012), who estimated that only 3.9% to 13.0% of gray whales that die in a given year end up stranding and being reported. This estimate of carcass detection, however, also included sparsely-populated coastlines of Baja California, Canada, and Alaska, for which the rate of carcass detection would be expected to be low. Since most U.S. cases of human-caused serious injury and mortality are documented from Washington, Oregon, and California waters, the Punt and Wade (2012) estimate of carcass recovery is not applicable to most documented cases. An appropriate correction factor for undetected anthropogenic mortality and serious injury of gray whales is currently not available.

A summary of human-caused mortality and serious injury resulting from ~~unknown~~ fishery and marine debris sources ~~(mainly pot/trap or net fisheries)~~ is given in Table 1 for the most recent 5-year period of 2012 to 2016 (Carretta *et al*. 2018b). ~~2008 to 2012.~~ Total observed and estimated entanglement-related human-caused ~~fishery~~ mortality and serious injury for ENP gray whales is 7.9 whales annually (Table 1). The mean annual entanglement-related serious injury and mortality level for PCFG gray whales is 0.85 whales, based on one observed death in CA Dungeness crab pot gear and three serious injuries in other fishing gear (Table 1). ~~22.25 animals (8 serious injuries, 8.25 prorated serious injuries, and 6 deaths), or 4.45 whales per year (Table 1). Total observed human-caused fishery mortality and serious injury for gray whales observed in the PCFG range and season for the period 2008 to 2012 is 0.75 animals (0.75 prorated serious injuries), or 0.15 whales per year (Table 1). Three gray whales from Table 1 (one death and two serious injuries) were detected in California waters during the known PCFG season, but were south of the area recognized by the IWC as the PCFG management area. It is possible that some of these whales could be PCFG whales, but no photographic identifications were available to establish their identity. They are included in ENP gray whale serious injury and death totals.~~ In addition to the mortality and serious injury totals listed above, there were 5 non-serious entanglement injuries of gray whales between 2012 and 2016 (Carretta *et al*. 2018b). Three non-serious injuries involved ENP gray whales, each with one record associated with the following sources: CA Dungeness crab pot fishery, unknown Dungeness crab pot fishery, and unidentified fishery interaction. During the same period, there were two non-serious injuries involving PCFG whales, one in tribal crab pot gear and the other in an unidentified gillnet fishery.

Unidentified whales represent approximately 15% of entanglement cases along the U.S. West Coast, (Carretta 2018). Observed entanglements may lack species IDs due to rough seas, distance from whales, or a lack of cetacean identification expertise. In previous stock assessments, these unidentified entanglements were not assigned to species, which results in underestimation of entanglement risk, especially for commonly-entangled species. To remedy this negative bias, a cross-validated species identification model was developed from known-species entanglements ('model data'). The model is based on several variables (location + depth + season + gear type + sea surface temperature) collectively found to be statistically-significant predictors of known-species entanglement cases (Carretta 2018). The species model was used to assign species ID probabilities for 21 unidentified whale entanglement cases ('novel data') during 2012-2016. The sum of species assignment probabilities for this 5-year period result in an additional 5.8 gray whale entanglements for 2012-2016. Of these 5.8 entanglements, only 0.8 occurred within the geographic range and seasonal limits considered to represent PCFG gray whales, while the remaining 5 are considered to be ENP gray whales. Unidentified whale entanglements typically involve whales seen at-sea with unknown gear configurations that are prorated to represent 0.75 serious injuries per entanglement case. Thus it is estimated that at least 5 x 0.75 = 3.75 additional ENP gray whale and 0.8 x 0.75 =0.6 PCFG serious injuries are represented from the

21 unidentified whale entanglement cases during 2012-2016. This represents 0.75 ENP gray whales and 0.1 PCFG gray whales annually.

Table 1. Human-caused deaths and serious injuries (SI) of gray whales from fishery-related and marine debris sources for the period 2008 to 2012 as recorded by NMFS stranding networks and observer programs.

Date of observation	Location	PCFG range N 41- N 52 AND season?	Description	Determination (SI Prorate value)
13-Oct-2012	Fort Bragg, CA	No	Entangled animal report; animal reported with rope around the peduncle which wasn't seen in photographs but photos did show green gillnet with cuts to the head; animal disappeared and final status is unknown.	SI
31-Aug-2012	Los Angeles, CA	No	Animal first detected near San Diego. Subadult gray whale reported entangled with small gauge, dark-colored line deeply embedded around its tail stock. Little gear trails. Entanglement was once more involved as indicated by scars on the animal's body. Animal in very poor condition - emaciated, scarred and a heavy load of cyamid amphipods. Black line around peduncle, 20 ft trailing; observed off san San Diego on 8/31, completely disentangled off L.A. 9/6, stranded dead 9/14/12.	Dead
22-Aug-2012	Prince William Sound, AK	No	Whale sighted by tour boat. Few details, other than part of a fishing net was observed being trailed from a gray whale's fin. Photos apparently available, but have not been located. Prince william William Sound. Extent and severity of entanglement unknown.	SI (0.75)
16-Jun-2012	Prince William Sound, AK	No	30' gray whale in prince william Prince William Sound entangled in gear. Thrashing at surface and moving at 4-5 knots. No wounds or chafing was observed. Gillnet, corkline (at least 12 floats), and leadline observed over animal's rostrum, body, and tailstock. Both pectoral flippers appeared pinned to body. Animal later appeared tired and was swimming at 2 knots. It was not relocated. Assigned serious injury because gear appears to be constricting movement of whale's flippers.	SI
13-May-2012	Monterey, CA	No	Animal entangled through mouth in at least two sets of suspected pot gear that that hang below. Animal anchored with a short scope in 28 feet of water to suspected pots. Bundle of gear, including 4 buoys lie under animal. Animal having some difficulty getting to surface. Animal eventually disentangled, but results of entanglement may still be life-threatening.	SI
8-May-2012	Eureka, CA	No	Entangled animal report; deep cuts from rope around peduncle and lacerations at fluke notch and lateral edge of fluke; successfully disentangled but long-term survival noted as questionable. Gear was collected and identified as Dungeness crab pot gear. Animal entirely freed of gear. Animal in fair condition and slightly emaciated. Deep cuts (~ 2 inches) from the rope around the peduncle remained. Gear was recovered. Results of entanglement may still be life threatening.	SI
5-May-2012	Monterey, CA	No	Whale watch vessel noticed from images taken of a 20 - 25 foot gray whale they had been observing earlier in the day, that animal was actually entangled. A small gauge line, likely from right side of mouth goes over the animal's back, and over blowholes, to left side of mouth. No buoys or trailing line were observed. Animal in fair condition. Animal sighted next day by whale watch vessel. Confirmed mouth entanglement, appears to be strapping material.	SI (0.75)
28-Apr-2012	Fort Bragg, CA	No	Small gray whale off fort bragg Fort Bragg, CA, in company of two other animals, trailing two buoys.	SI (0.75)
21-Apr-2012	San Simeon, CA	No	Rope like marks on caudal peduncle. Rope impression on pectoral fin. Photos taken.	Dead
17-Apr-2012	Laguna Beach, CA	No	40-foot gray whale reported entangled with approximately 150 feet of line trailing. Four spongex bullet buoys lie along the left side of the animal. Entanglement involves the mouth, a wrap over the head, and the left pectoral flipper. Entanglement appears recent. Partially disentangled on 5/3/12 by fishermen.	SI (0.75)
24-Mar-2012	San Diego, CA	No	Entangled animal report; gillnet gear around peduncle; response effort resulted in successful disentanglement with >100 ft of pink gillnet removed from animal, but animal subsequently observed dead on 03/27 (floating, skin sample taken, no necropsy). Net	Dead

			removed on 03/24 found to contain one dead ca sea lion and three dead sharks.	
28-Jan-2012	San Diego, CA	No	Entangled animal report; towing two orange buoys and at least 150 feet of line; unknown fishery, reported as possible gillnet; no response effort.	SI (0.75)
17-Jan-2012	Unimak Pass, AK	No	A 40' whale was caught in cod pot gear near Unimak Pass. Lines were cut by boat crew and buoys were recovered, however, the pot and some line remained in the water. Any line possibly remaining on animal thought to be minimal. Gray whale species determination made following extensive questioning by local biologist. Determination: prorated serious injury because gear possibly remains on animal.	SI (0.75)
25-Aug-2011	San Mateo, CA	No	One white "crab pot" buoy next to body by left pectoral fin; float stayed next to body and did not change position; animal remained in same position - possibly anchored; only observed for ~2 min; not resighted, no rescue, outcome unknown.	SI
12-Sep-2010	Central Bering Sea	No	Bering Sea / Aleutian Islands flatfish trawl fishery: 12 m animal caught in gear. Photos taken.	Dead
11-May-2010	Orange County CA	No	Free-swimming animal entangled in gillnet; animal first observed inside Dana Point Harbor on 5/11/10; animal successfully disentangled on 5/12/10 & swam out of harbor; animal observed alive in surf zone for several hours on 5/14/10 off Doheny State Beach before washing up dead on beach	Dead
7-May-2010	Cape Foulweather OR	No	Entangled in 3 crab pots, whale not relocated.	SI (0.75)
16-Apr-2010	Seaside OR	No	27-ft long gray whale stranded dead, entangled in crab pot gear	Dead
8-Apr-2010	San Francisco CA	No	Rope wrapped around caudal peduncle; identified as gray whale from photo. Free-swimming, diving. No rescue effort, no resightings, final status unknown	SI
5-Mar-2010	San Diego	No	Free-swimming entangled whale reported by member of the public; no rescue effort initiated; no resightings reported; final status unknown.	SI (0.75)
21-Jul-2009	Trinidad Head CA	Yes	Free-swimming animal with green gillnet, rope & small black floats wrapped around caudal peduncle; report received via HSU researcher on scene during research cruise; animal resighted on 3 Aug; no rescue effort initiated. Photos show rope cutting into caudal peduncle. This whale was re-sighted in 2010 and 2011, still trailing gear. Whale was resighted in 2013 and had shed gear, and was apparently in good health (Jeff Jacobsen, pers. comm.).	NSI
24-Jun-2009	Clallam County, WA	Yes	Whale found entangled in tribal set gillnet in morning. Net had been set 8 pm previous day. Whale able to breath, but not swim freely and was stationary in net. Right pectoral flipper and head were well-wrapped in net webbing. In response to disentanglement attempts, whale reacted violently and swam away. The net was retrieved and found to be torn in two. No confirmation on whether whale was completely free of netting.	SI (0.75)
9-Apr-2009	Sitka, AK	No	Thick black line wrapped twice around whale's body posterior to the eyes was cut and pulled away by private citizen. Animal swam away and dove.	SI (0.75)
25-Mar-2009	Seal Beach CA	No	Free-swimming animal with pink gillnet wrapped around head, trailing 4 feet of visible netting; report received via naturalist on local whale watch vessel; no rescue effort initiated; final status unknown	SI (0.75)
31-Jan-2009	San Diego CA	No	Free-swimming animal towing unidentified pot/trap gear; report received via USCG on scene; USCG reported gear as 4 lobster pots; final status unknown	SI (0.75)
16-Apr-2008	Eel River CA	No	Observed 12 miles west of Eel River by Humboldt State University personnel. It was unknown sex, with an estimated length of 20 ft and in emaciated condition. The animal was described as towing 40-50 feet of line & 3 crab pot buoys from the caudal peduncle and moving very slowly. Vessel retrieved the buoys, pulled them and ~20 ft of line onto the deck and cut it loose from the whale. The whale swam away slowly with 20-30 feet of line still entangling the peduncle, outcome unknown. Identification numbers on buoy traced to crab pot fishery gear that was last fished in Bering Sea in December 2007.	SI

Subsistence/Native Harvest Information

Subsistence hunters in Russia and the United States have traditionally harvested whales from the ENP stock in the Bering Sea, although only the Russian hunt has persisted in recent years (Huelsbeck 1988; Reeves 2002). In 2005, the Makah Indian Tribe requested authorization from NOAA/NMFS, under the MMPA and the Whaling Convention Act, to resume limited hunting of gray whales for ceremonial and subsistence purposes in the coastal portion of their usual and accustomed (U&A) fishing grounds off Washington State (NMFS ~~2008~~2015). The spatial overlap of the Makah U&A and the summer distribution of PCFG whales has management implications. The hunt proposal by the Makah Tribe includes time/area restrictions designed to reduce the probability of killing a PCFG whale and to focus the hunt on whales migrating to/from feeding areas to the north. The Makah proposal also includes catch limits for PCFG whales that result in the hunt being terminated if these limits are met. Also, observations of gray whales moving between the WNP and ENP highlight the need to estimate the probability of a gray whale observed in the WNP being taken during a ~~hunt by the~~ Makah hunt ~~Tribe~~ (Moore and Weller 2013). NMFS has ~~published a notice of intent to prepare an~~ prepared a draft environmental impact statement (DEIS) on the proposed hunt (NMFS ~~2012~~2015) and the IWC has evaluated the potential impacts of the proposed hunt and other sources of human-caused mortality on PCFG whales and concluded, with certain qualifications, that the proposed hunt meets the Commission's conservation objectives (IWC 2013). The Scientific Committee has continued to ~~has not scheduled an implementation review of the impacts of the Makah hunt on whales using summering feeding areas in the WNP, but is continuing to~~ investigate stock structure of north Pacific gray whales and has convened five workshops on the subject between 2014 and 2018. The objective of the workshops has been to develop a series of range-wide stock structure hypotheses, using all available data sources (*e.g.* photo-ID, genetics, tagging), that can be tested within a modelling framework (IWC 2017). Completion of this work is scheduled for 2018-2019. ~~may schedule such a review in the future (IWC 2013)~~. In 2012, the IWC approved a 6-year quota (2013-2018) of 744 gray whales, with an annual cap of 140, for Russian and U.S. (Makah Indian Tribe) aboriginals based on the joint request and needs statements submitted by the U.S. and the Russian ~~federation~~Federation. The U.S. and the Russian Federation have agreed that the quota will be shared with an average annual harvest of 120 whales by the Russian Chukotka people and 4 whales by the Makah Indian Tribe. Total takes by the Russian hunt during the past five years were: ~~130 in 2008, 116 in 2009, 118 in 2010, 128 in 2011, and~~ 143 in 2012, 127 in 2013, 124 in 2014, 125 in 2015, and 120 in 2016 (International Whaling Commission). There were no whales taken by the Makah Indian Tribe during that period because their hunt request is still under review. Based on this information, the annual subsistence take averaged ~~127~~ 128 whales during the 5-year period from ~~2008 to~~ 2012 to 2016. The IWC reports a total of 3,787 gray whales harvested from annual aboriginal subsistence hunts for the 32-year period 1985 to 2016, which includes struck and lost whales.

Other Mortality

Ship strikes are a source of mortality and serious injury for gray whales ~~(Table 2)~~. For the most recent five-year period, ~~2008-2012~~ 2012-2016, the total serious injury and mortality of ENP gray whales attributed to ship strikes is ~~9.8~~ 4 animals (including ~~7~~ 4 deaths and 2 non-serious injuries) or 0.8 whales annually ~~, 2 serious injuries, and 0.8 prorated serious injuries, or 2.0 whales per year (Table 2, Carretta et al. 2013, Carretta et al. 2014b.~~Carretta *et al.* 2018b). ~~The total~~Total ship strike serious injury and mortality of gray whales observed in the PCFG range and season during this same period is ~~0.52~~ 2 animals, or ~~0.1~~ 0.4 whales per year (~~Table 2~~ Carretta *et al.* 2018b). ~~One gray whale ship strike in Table 2 was detected in California waters during the known PCFG season, but was south of the area recognized by the IWC as the PCFG management area. It is possible that this animal could be a PCFG whale, but no photographic identification was available to establish its identity. It is included in ENP gray whale serious injury and death totals.~~ Additional mortality from ship strikes probably goes unreported because the whales either do not strand, are undetected, or ~~do not have~~lack obvious signs of trauma.

~~In February 2010, a gray whale stranded dead near Humboldt, CA with parts of two harpoons embedded in the body. Since this whale was likely harpooned during the aboriginal hunt in Russian waters, it would have been counted as "struck and lost" in the harvest data.~~

HABITAT CONCERNS

Near shore industrialization and shipping congestion throughout the migratory corridors of the ENP gray whale stock represent risks by increasing the likelihood of exposure to pollutants and ship strikes, as well as a general degradation of the habitat.

Evidence indicates that the Arctic climate is changing significantly, resulting in a reductions in sea ice cover (Johannessen *et al*. 2004, Comiso *et al*. 2008). These changes are likely to affect gray whales. For example, the summer range of gray whales has greatly expanded in the past decade (Rugh *et al*. 2001). Bluhm and Gradinger (2008) examined the availability of pelagic and benthic prey in the Arctic and concluded that pelagic prey is likely to increase while benthic prey is likely to decrease in response to climate change. They noted that marine mammal species that exhibit trophic plasticity (such as gray whales which feed on both benthic and pelagic prey) will adapt better than trophic specialists.

Global climate change is also likely to increase human activity in the Arctic as sea ice decreases, including oil and gas exploration and shipping (Hovelsrud *et al*. 2008). Such activity will increase the chance of oil spills and ship strikes in this region. Gray whales have demonstrated avoidance behavior to anthropogenic sounds associated with oil and gas exploration (Malme *et al*. 1983, 1984) and low-frequency active sonar during acoustic playback experiments (Buck and Tyack 2000, Tyack 2009). Ocean acidification could reduce the abundance of shell-forming organisms (Fabry *et al*. 2008, Hall-Spencer *et al*. 2008), many of which are important in the gray whales' diet (Nerini 1984).

~~**Table 2.** Summary of gray whale serious injuries (SI) and deaths attributed to vessel strikes for the five-year period 2008-2012. No vessel strikes were reported in 2012.~~

Date of observation	Location	PCFG range N 41 - N 52 AND season?	Description	Determination (SI prorate value)
6-Jun-2011	San Mateo CA	No	Massive hemorrhage into the thorax, blood clots around lungs. Lesions indicate massive trauma. Due to carcass position, the skeleton could not be completely examined (lying on back, top of skull in sand).	Dead
8-Apr-2011	San Francisco CA	No	Crushed mandible.	Dead
12-Feb-2011	Los Angeles CA	No	Private recreational vessel collided with free-swimming animal; animal breached just prior to contact, bouncing off side of vessel; dove immediately following contact & was not resighted; no blood observed in water; final status unknown; skin sample collected from vessel and genetically identified as a female gray whale. Vessel size assumed less than 65 ft and speed unknown.	SI (0.14)
22-Jan-2011	San Diego CA	No	Pleasure sailboat collided with free-swimming animal; animal dove immediately following contact & was not resighted; no blood observed in water; final status unknown. Vessel size assumed less than 65 ft. And speed unknown.	SI (0.14)
12-Mar-2010	Santa Barbara CA	No	21 meter sailboat underway at 13 kts collided with free-swimming animal; whale breached shortly after collision; no blood observed in water; minor damage to lower portion of boat's keel; final status unknown; DNA analysis of skin sample confirmed species.	SI
16-Feb-2010	San Diego CA	No	Free-swimming animal with propeller-like wounds to dorsum.	SI (0.52)
9-Sep-2009	Quileute River WA	Yes	USCG vessel reported to be traveling at 10 knots when they hit the gray whale at noon on 9/9/2009. The animal was hit with the prop and was reported alive after being hit, blood observed in water.	SI (0.52)
1-May-2009	Los Angeles CA	No	Catalina island transport vessel collided with free-swimming calf accompanied by adult animal; calf was submerged at time of collision; pieces of flesh & blood observed in water; calf never surfaced; presumed mortality.	SI
27-Apr-2009	Whidbey Is. WA	No	Large amount of blood in body cavity, bruising in some areas of blubber layer and in some internal organs. Findings suggestive of blunt force trauma likely caused by collision with a large ship.	Dead
5-Apr-2009	Sunset Beach CA	No	Dead stranding; 3 deep propeller-like cuts on right side, just anterior of genital opening; carcass towed out to sea	Dead
4-Apr-2009	Ilwaco WA	No	Necropsied, broken bones in skull; extensive hemorrhage head and thorax; sub-adult male	Dead
1-Mar-2008	Mexico	No	Carcass brought into port on bow of cruise ship; collision occurred betweeen ports of San Diego and Cabo San Lucas between 5:00 p.m. On 2/28 & 7:20 a.m. On 3/1	Dead
7-Feb-2008	Orange County CA	No	Carcass; propeller-like wounds to left dorsum from mid-body to caudal peduncle; deep external bruising on right side of head; field necropsy revealed multiple cranial fractures	Dead

STATUS OF STOCK

In 1994, the ENP stock of gray whales was removed from the List of Endangered and Threatened Wildlife (the List), as it was no longer considered endangered or threatened under the Endangered Species Act (NMFS 1994). Punt and Wade (2012) estimated the ENP population was at 85% of carrying capacity (K) and at 129% of the maximum net productivity level (MNPL), with a probability of 0.884 that the population is above MNPL and therefore within the range of its optimum sustainable population (OSP).

Even though the stock is within OSP, abundance will fluctuate as the population adjusts to natural and human-caused factors affecting carrying capacity (Punt and Wade 2012). It is expected that a population close to or at carrying capacity will be more susceptible to environmental fluctuations (Moore *et al*. 2001). The correlation between gray whale calf production and environmental conditions in the Bering Sea may reflect this (Perryman et al. 2002; Perryman and Weller 2012). Overall, the population nearly doubled in size over the first 20 years of monitoring, and has fluctuated for the last 30 years, with a recent increase to over 26,000 whales. Carrying capacity for this stock was estimated at 25,808 whales in 2009 (Punt and Wade 2012), however the authors noted that carrying capacity was likely to fluctuate along with environmental changes, especially those related to the productivity of arctic feeding grounds. ~~around its average carrying capacity. This is consistent with a population approaching K~~.

Based on ~~2008-2012~~ 2012-2016 data, the estimated annual level of human-caused mortality and serious injury for ENP gray whales includes Russian harvest (~~127~~ 128), mortality and serious injury from commercial fisheries (~~4.45~~7.9), marine debris (0.35), ~~and~~ ship strikes (~~2.0~~ 0.8), and unidentified whale entanglements assigned as gray whales (0.75) totals ~~133~~ 138 whales per year, which does not exceed the PBR (~~624~~ 801). Therefore, the ENP stock of gray whales is not classified as a strategic stock.

The IWC completed an implementation review for ENP gray whales (including the PCFG) in 2012 (IWC 2013) and concluded that harvest levels (including the proposed Makah hunt) and other human caused mortality are sustainable, given the ~~current~~ population abundance (Laake *et al*. 2012, Punt and Wade 2012).

PCFG gray whales do not currently have a formal status under the MMPA.~~,~~ Abundance estimates of PCFG whales increased from 1998 through 2004, remained stable for the period 2005-2010, and have steadily increased during the 2011-2015 time period (Calambokidis *et al.* 2017).~~though the population size appears to have been stable since 2003, based on photo-ID studies (Calambokidis *et al*. 2014, IWC 2012)~~. Total annual human-caused mortality of PCFG gray whales during the period ~~2008 to~~ 2012 to 2016 includes ~~deaths~~ mortality and serious injuries due to commercial fisheries (~~0.15~~ 0.7/yr), tribal fisheries (0.15/yr), ~~and~~ ship strikes (~~0.1~~ 0.4/yr), plus unidentified whale entanglements assigned as PCFG gray whales (0.1), or ~~0.25~~ 1.35 whales annually. This does not exceed the PBR level of ~~3.1~~ 3.5 whales for this population. Levels of human-caused mortality and serious injury resulting from commercial fisheries and ship strikes for both ENP and PCFG whales represent minimum estimates as recorded by stranding networks or at-sea sightings.

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GRAY WHALE (*Eschrichtius robustus*): Western North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Gray whales occur along the eastern and western margins of the North Pacific. In the western North Pacific (WNP), gray whales feed during summer and fall in the Okhotsk Sea off northeast Sakhalin Island, Russia, and off southeastern Kamchatka in the Bering Sea (Weller *et al.* 1999, 2002; Vertyankin *et al.* 2004; Tyurneva *et al.* 2010; Burdin *et al.* ~~2013~~ 2017; Figure 1). —Historical evidence indicates that the coastal waters of eastern Russia, the Korean Peninsula and Japan were once part of the migratory route in the WNP and that areas in the South China Sea may have been used as wintering grounds (Weller *et al.* 2002; Weller *et al.* 2013a). Present day records of gray whales off Japan (Nambu *et al.* 2010; Nakamura *et al.* 2017a; Nakamura *et al.* 2017b) and China are infrequent (Wang 1984; Zhu 2002; Wang *et al.* 2015) and the last known record from Korea was in 1977 (Park 1995; Kim *et al.* 2013). While recent observations of gray whales off the coast of Asia remain sporadic, observations off Japan, mostly from the Pacific coast, appear to be increasing in the past two decades (Nakamura *et al.* 2017b).

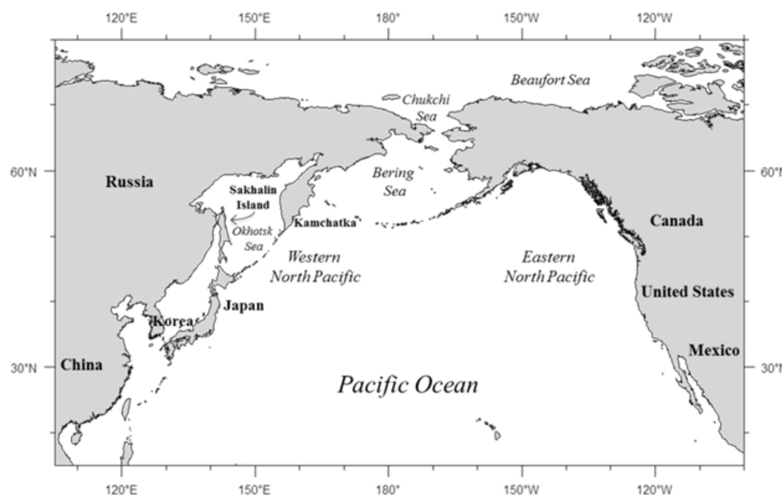

Figure 1. Range map of the Western North Pacific Stock of gray whales, including summering areas off Russia and wintering areas in the western and eastern Pacific.

~~Some gray whales observed feeding off Sakhalin and Kamchatka migrate during the winter to the west coast of North America in the eastern North Pacific (Mate *et al.* 2011; Weller *et al.* 2012; Urbán *et al.* 2013), while others, including at least one whale first identified as a calf off Sakhalin, migrate to areas off Asia in the WNP (Weller *et al.* 2008; Weller *et al.* 2013a). Despite the observed movements between the WNP and eastern North Pacific (ENP), genetic comparisons show significant mitochondrial and nuclear genetic differences between whales sampled in the ENP and those sampled on the feeding ground off Sakhalin Island in the WNP (LeDuc *et al.* 2002; Lang *et al.* 2011). While a few previously unidentified non-calves are identified annually, a recent population assessment using photo-identification data from 1994 to 2011 fitted to an individually-based model found that whales feeding off Sakhalin Island have been demographically self-contained, at least in recent years, as new recruitment to the population is almost exclusively a result of calves born to mothers from within the group (Cooke *et al.* 2013).~~

~~Historical evidence indicates that the coastal waters of eastern Russia, the Korean Peninsula and Japan were once part of the migratory route in the WNP and that areas in the South China Sea may have been used as wintering grounds (Weller *et al.* 2002; Weller *et al.* 2013a). However, contemporary records of gray whales off Asia are rare, with only 13 from Japanese waters between 1990 and 2007 (Nambu *et al.* 2010) and 24 from Chinese waters since 1933 (Wang 1984; Zhu 2002). The last known record of a gray whale off Korea was in 1977 (Park 1995; Kim *et al.* 2013). While recent observations of gray whales off the coast of Asia are infrequent, they nevertheless continue to occur, including: (1) March/April 2014 – one or possibly two gray whales were sighted and photographed off the Shinano River in Teradomari (Niigata Prefecture) on the Sea of Japan coast of Honshu, Japan (Kato *et al.* 2014), (2) March 2012 – a gray whale was sighted and photographed in Mikawa Bay (Aichi Prefecture), on the Pacific coast of Honshu, Japan (Kato *et al.* 2012), and (3) November 2011 – a 13 m female gray whale was taken in fishing gear offshore of Baiqingxiang, China, in the Taiwan Strait (Zhu 2012).~~

Information from tagging, photo-identification and genetic studies show that some whales identified in the WNP off Russia have been observed in the eastern North Pacific (ENP), including coastal waters of Canada, the U.S. and Mexico (Lang 2010; ~~Mate *et al.* 2011;~~ Weller *et al.* 2012; Urbán *et al.* 2013, Mate *et al.* 2015). In combination, these studies have recorded ~~a total of 27~~ about 30 gray whales observed in both the WNP and ENP. Some whales that feed off Sakhalin Island in summer migrate east across the Pacific to the west coast of North America in winter, while others migrate south to waters off Japan and China (Weller *et al.* 2016). Despite the observed movements of some gray whales between the WNP and ENP, significant differences in their mitochondrial and nuclear DNA exist (LeDuc *et al.* 2002; Lang *et al.* 2011). Taken together, these observations indicate that not all gray whales in the WNP share a common wintering ground ~~(Weller *et al.* 2013a)~~.

In 2012, the National Marine Fisheries Service convened a scientific task force to appraise the currently recognized and emerging stock structure of gray whales in the North Pacific (Weller *et al.* 2013b). The charge of the task force was to evaluate gray whale stock structure as defined under the Marine Mammal Protection Act (MMPA) and implemented through the National Marine Fisheries Service's Guidelines for Assessing Marine Mammal Stocks (GAMMS; NMFS 2005). Significant differences in both mitochondrial and nuclear DNA between whales sampled off Sakhalin Island (WNP) and whales sampled in the ENP provided convincing evidence that resulted in the task force advising that WNP gray whales should be recognized as a population stock under the MMPA and GAMMS guidelines. Given the interchange of some whales between the WNP and ENP, including seasonal occurrence of WNP whales in U.S. waters, the task force agreed that a stand-alone WNP gray whale population stock assessment report was warranted.

POPULATION SIZE

Photo-identification data collected off Sakhalin Island between 1994 and ~~2011~~ 2016 ~~on the gray whale summer feeding ground off Sakhalin Island in the WNP~~ were fitted to an individually-based population model (Cooke *et al.* 2016). Using the best fitting model, the aged 1+ (non-calf) population size was estimated to be 175 whales (Bayesian 95% CI 158-193) in 2016 (Cooke *et al.* 2016). ~~used to calculate an abundance estimate of 140 (SE = ± 6, CV=0.043) whales for the age 1-plus (non-calf) population size in 2012 (Cooke *et al.* 2013). Some whales (approximately 70 individuals) sighted during the summer off southeastern Kamchatka have not been sighted off Sakhalin Island, but it is as yet unclear whether those whales are part of the WNP stock (IWC 2014).~~

Minimum Population Estimate

Although Cooke *et al.* (2016) did not report a coefficient of variation (CV) for their population size estimate, one can be approximated via simulation of a log-normal distribution, using their reported abundance and confidence limits. The estimated CV of the abundance estimate is 0.05, which is similar to previously reported estimates for this stock, using similar mark-recapture methods (Cooke *et al.* 2013). The minimum population estimate (N_{min}) for the WNP stock is calculated from Equation 1 from the PBR Guidelines (Wade and Angliss 1997): $N_{min} = N/\exp(0.842\times[\ln(1 + [CV(N)]^2)]^{½})$ and the abundance estimate of 175 (CV=0.05) ~~140 (CV=0.043)~~ whales from Cooke *et al.* (2016), ~~(2013),~~ resulting in a minimum population estimate of 167 ~~135~~ gray whales on the summer feeding ground off Sakhalin Island in the WNP.

Current Population Trend

The Sakhalin Island population was estimated to be increasing from 2005 through 2015 at an average rate between 2-4% annually (Cooke *et al.* 2016). ~~The WNP gray whale stock has increased over the last 10 years (2002-2012). The estimated realized average annual rate of population increase during this period is 3.3% per annum (± 0.5%) (Cooke *et al.* 2013).~~

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

An analysis of the ENP gray whale population led to an estimate of R_{max} of 0.062, with a 90% probability the value was between 0.032 and 0.088 (Punt and Wade 2012). This value of R_{max} is also applied to WNP gray whales, as it is currently the best estimate of R_{max} available for any gray whale population.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (167) ~~(135),~~ times one-half the estimated maximum annual growth rate for a gray whale population (½ of 6.2% for the Eastern North Pacific Stock, Punt and Wade 2012), times a recovery factor of 0.1 (for an endangered stock with $N_{min} < 1{,}500$, Taylor *et al.* 2003), and also multiplied by estimates for the proportion of the stock that uses U.S. EEZ waters (0.575) and the proportion of the year that those animals are in the U.S. EEZ (3 months, or 0.25 years) (Moore and Weller 2013), resulting in a PBR of 0.07 ~~0.06~~ WNP gray whales per year, or approximately 1 whale every ~~17~~ 14 years (if abundance and other parameters in the PBR equation remained constant over that time period).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

~~**Serious Injury Guidelines**~~

~~NMFS uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to distinguis serious from non-serious injury (Angliss and DeMaster 1998, Andersen *et al.* 2008, NOAA 2012). NMFS defines serious injury as an "injury that is more likely than not to result in mortality".~~

Fisheries Information

The decline of gray whales in the WNP is attributable to commercial hunting off Korea and Japan between the 1890s and 1960s. The pre-exploitation abundance of WNP gray whales is unknown, but has been estimated to be between 1,500 and 10,000 individuals (Yablokov and Bogoslovskaya 1984). By 1910, after some commercial exploitation had already occurred, it is estimated that only 1,000 to 1,500 gray whales remained in the WNP population (Berzin and Vladimirov 1981). The basis for how these two estimates were derived, however, is not apparent (Weller *et al.* 2002). By the 1930s, gray whales in the WNP were considered by many to be extinct (Mizue 1951; Bowen 1974).

~~Today, a~~ A significant threat to gray whales in the WNP ~~is~~ are incidental catches in coastal net fisheries (Weller *et al.* 2002; ~~Kato~~ Nakamura *et al.* 2017b~~2~~; Weller *et al.* 2008; Weller *et al.* 2013a; Burkanov *et al.* 2017). Between 2005 and 2007, four female gray whales (including one mother-calf pair and one yearling) died in fishing nets on the Pacific coast of Japan. In addition, one adult female gray whale died as a result of a fisheries interaction in November 2011 off Pingtan County, China (~~Zhu 2012~~ Wang *et al.* 2015). An analysis of anthropogenic scarring of gray whales photographed off Sakhalin Island found that at least 18.7% (n=28) of 150 individuals identified between 1994 and 2005 had evidence of previous entanglements in fishing gear but where the scars were acquired is unknown (Bradford *et al.* 2009).~~, further highlighting the overall risks coastal fisheries pose to WNP gray whales.~~

~~In summer 2013,~~ Trap nets for Pacific salmon ~~net fishing was observed for the first time on the gray whale feeding ground off~~ have been deployed in the feeding area off northeastern Sakhalin Island since 2013, resulting in two known entanglements and one probable entanglement mortality (Burkanov *et al.* 2017). ~~Observations of whales within 100 m of salmon fishing nets have been made and a male gray whale was observed dragging fishing gear (rope), with a related injury on the caudal peduncle at the dorsal insertion point with the flukes (Weller *et al.* 2014).~~

Given that some WNP gray whales occur in U.S. waters, there is some probability of WNP gray whales being killed or injured by ship strikes or entangled in fishing gear within U.S. waters.

Subsistence/Native Harvest Information

In 2005, the Makah Indian Tribe requested authorization from NOAA/NMFS, under the Marine Mammal Protection Act of 1972 (MMPA) and the Whaling Convention Act, to resume limited hunting of gray whales for ceremonial and subsistence purposes in the coastal portion of their usual and accustomed (U&A) fishing grounds off Washington State (NOAA ~~2008~~ 2015). Observations of gray whales moving between the WNP and ENP highlight the need to estimate the probability of a gray whale observed in the WNP being taken during a hunt by the Makah Tribe (Moore and Weller 2013). Given conservation concerns for the WNP population, the Scientific Committee of the International Whaling Commission (IWC) emphasized the need to estimate the probability of a WNP gray whale being struck during aboriginal gray whale hunts (IWC 2012). Additionally, NOAA is required by the National Environmental Policy Act (NEPA) to prepare an Environmental Impact Statement (EIS) pertaining to the Makah's request. The EIS needs to address the likelihood of a WNP whale being taken during the proposed Makah gray whale hunt.

To estimate the probability that a WNP whale might be taken during the proposed Makah gray whale hunt, four alternative models were evaluated. These models made different assumptions about the proportion of WNP whales that would be available for the hunt or utilized different types of data to inform the probability of a WNP whale being taken (Moore and Weller 2013). Based on the preferred model, the probability of striking at least one WNP whale in a single year was estimated to range from 0.006 – 0.012 across different scenarios for the annual number of total gray whales that might be struck. This corresponds to an expectation of ≥ 1 WNP whale strike in one of every 83 to 167 years. This analysis was based on a 2012 abundance estimate of 155 (95% CI 142-165) which is slightly smaller than the 2016 abundance estimate of 175 (95% CI 158-193) reported by Cooke *et al.* (2016). It still represents the best estimate of WNP gray whale use of U.S. waters at this time.

HABITAT ISSUES

Near shore industrialization and shipping congestion throughout the migratory corridors of the WNP gray whale stock represent risks by increasing the likelihood of exposure to pollutants and ship strikes as well as a general degradation of the habitat. In addition, the summer feeding area off Sakhalin Island is a region rich with offshore oil and gas reserves. Two major offshore oil and gas projects now directly overlap or are in near proximity to this important feeding area, and more development is planned in other parts of the Okhotsk Sea that include the migratory routes of these whales. Operations of this nature have introduced new sources of underwater noise, including seismic surveys, increased shipping traffic, habitat modification, and risks associated with oil spills (Weller *et al.* 2002). During the past decade, a Western Gray Whale Advisory Panel, convened by the International Union for Conservation of Nature (IUCN), has been providing scientific advice on the matter of anthropogenic threats to gray whales in the WNP~~ (see http://www.iucn.org/wgwap/)~~. Ocean acidification could reduce the abundance of shell-forming organisms (Fabry *et al.* 2008, Hall-Spencer *et al.* 2008), many of which are important in the gray whales' diet (Nerini 1984).

STATUS OF STOCK

The WNP stock is listed as "Endangered" under the U.S. Endangered Species Act of 1973 (ESA) and is therefore also considered "strategic" and "depleted" under the MMPA. At the time the ENP stock was delisted, the WNP stock was thought to be geographically isolated from the ENP stock. ~~Recent d~~ Documentation of some whales moving between the WNP and ENP seems to indicate otherwise (Lang 2010; Mate *et al.* 2011; Weller *et al.* 2012; Urbán *et al.* 2013). Other research findings, however, provide continued support for identifying two separate stocks of North Pacific gray whales, including: (1) significant mitochondrial and nuclear genetic differences between whales that feed in the WNP and those that feed in the ENP (LeDuc *et al.* 2002; Lang *et al.* 2011), (2) recruitment into the WNP stock is almost exclusively internal (Cooke *et al.* 2013), and (3) the abundance of the WNP stock remains low while the abundance of the ENP stock grew steadily following the end of commercial whaling (Cooke *et al.* ~~2013~~2017). As long as the WNP stock remains listed as endangered under the ESA, it will continue to be considered as depleted under the MMPA.

In the past 5 years considerable effort has been undertaken to comprehensively assess the Pacific-wide stock structure of gray whales. For example, between 2014 and 2018 the International Whaling Commission (IWC) has convened five workshops on this matter. The objective of the workshops has been to develop a series of range-wide stock structure hypotheses, using all available data sources (*e.g.* photo-id, genetics, tagging), that can be tested within a modelling framework (IWC 2017). Completion of this work is scheduled for 2018-2019. Additionally, Cooke *et al.* (2017) conducted an updated assessment of gray whales in the WNP using an individually-based stage-structured population model with modified stock definitions that allows for the possibility of multiple feeding/breeding groups. Results from this work suggest that whales summering off Sakhalin Island and southeast Kamchatka, combined, appear to represent a genetically and demographically self-contained subpopulation that is characterized by preferential mating. In this scenario, whales identified feeding off Sakhalin represent about 2/3 of the combined Sakhalin Island-Kamchatka subpopulation. Further substructure within the subpopulation was not excluded by Cooke *et al.* (2017), including the possibility of less than 50 mature whales that breed only in the WNP. The IWC analysis is ongoing and the results of Cooke *et al.* (2017) are considered provisional pending further exploration of additional gray whale stock structure hypotheses.

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

AUG 27 2018

John Calambokidis
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Cascadia Research Collective
218 ½ W 4th Avenue
Olympia, WA 98501

Dear Mr. Calambokidis:

Thank you for the letter from Timothy Ragen to Chris Oliver, Assistant Administrator for Fisheries, transmitting recommendations from the March 2018 meeting of the Pacific Scientific Review Group (SRG). Your letter was forwarded to me because the Office of Protected Resources within NOAA Fisheries is responsible for national programs under the Marine Mammal Protection Act and leads NOAA Fisheries' coordination of the SRGs.

The SRG has made many valuable recommendations to help guide NOAA Fisheries' marine mammal science and management, which are addressed in the enclosure. I want to thank you for agreeing to act as Chair of the Pacific SRG upon the departure of Dr. Scott and Dr. Ragen. I appreciate the continued service and contributions by members of the Pacific SRG in providing advice and support to NOAA Fisheries in accordance with the Marine Mammal Protection Act. I look forward to our continued partnership to improve the science supporting the conservation of marine mammals.

Sincerely,

for Donna S. Wieting
Director, Office of Protected Resources

Enclosure

cc: Chris Oliver, Assistant Administrator for Fisheries
Francisco Werner, Director of Scientific Programs and Chief Science Advisor
Ned Cyr, Director, Office of Science and Technology

Responses to 2018 Recommendations of the Pacific Regional Scientific Review Group

Resources for and timeliness of Stock Assessment Report-related research

(1) *The PSRG recommends that NMFS bolster the resources available for stock assessment research and reporting.*

NOAA Fisheries agrees that SARs are critical for the management and conservation of marine mammals and ecosystems, and is aware that level funding and attrition have led to challenges. We will continue to consider all of our marine mammal research needs as we evaluate and prioritize activities that can be conducted with available funding.

(2) *The PSRG also recommends that NMFS streamline their SAR processes to ensure that the information included in SARs is as up-to-date as possible.*

The SARs are based upon the best available scientific information, and NMFS strives to update the SARs with as timely data as possible. In order to develop annual mortality and serious injury estimates, we do our best to ensure all records are accurately accounted for in that year. In some cases, this is contingent on such things as bycatch analysis, data entry, and assessment of available data to make determinations of injury severity, confirmation of species based on morphological and/or molecular samples collected, etc. The SARs incorporate injury determinations that have been assessed pursuant to the NMFS 2012 Policy and Procedure for Distinguishing Serious from Non-Serious Injury of Marine Mammals (NMFS 2012a, NMFS 2012b), which requires several phases of review. Reporting on incomplete annual mortality and serious injury estimates could result in underestimating actual levels. The MMPA requires us to report mean annual mortality and serious injury estimates, and we ensure that we are accounting for all available data before we summarize those data.

Specific to humpback whale and blue whale interactions with human activities, while there is sometimes a delay in incorporating this information into the SARs, the agency is continually working on addressing this issue. For example, we updated the final 2017 SARs to note the availability of new vessel strike estimates included in the publication of Rockwood *et al.* (2017) and have incorporated the results of those vessel strike estimates into the draft 2018 SARs for both humpback and blue whales.

Inter-regional coordination

(3) *The PSRG recommends that, when marine mammal stocks occur in multiple regions, NMFS coordinate research and management programs among regions to ensure management and conservation goals are met.*

We recognize the value of coordination among Centers and Regions for stocks that occur in multiple regions. Ongoing research and management efforts for many of these species have been conducted collaboratively across regions whenever possible. NMFS will continue to coordinate and will also revise the process for drafting and reviewing SARs to allow cross-region review and input, especially for large whales that migrate between regions, such as humpback whales, fin whales, and blue whales. NMFS plans to provide opportunities for both the Alaska and Pacific Scientific Review Groups to review relevant research and management of such transboundary species. The next Pacific Scientific Review Group meeting, which will likely be held in Washington State, will also include an agenda item on transboundary large whale species, and researchers from Alaska Fisheries Science Center and the Alaska Scientific Review Group will be invited to attend the meeting to provide input.

Vessel-based cetacean surveys

(4) *The PSRG recommends that NMFS make every effort to sustain the multi-year, multi-region ship survey schedule established with the Bureau of Ocean Energy Management and the Navy.*

Leveraging inter-agency partnerships to support long-term, national, multispecies cetacean and ecosystem surveys is an agency priority. NOAA Fisheries has maintained its support for the ongoing Atlantic Marine Assessment Program for Protected Species (AMAPPS) in the Western Atlantic and the recently initiated Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) in the Gulf of Mexico, and the Pacific Marine Assessment Program for Protected Species (PacMAPPS) by providing and prioritizing aircraft, ship, and staff time to accomplish mutually beneficial project goals. The Southwest Fisheries Science Center (SWFSC) and Pacific Islands Science Center (PIFSC) are fully committed to the PacMAPPS partnership with BOEM and the Navy, which provides a survey schedule for Hawaiian, U.S. West Coast, Mariana Archipelago, and Gulf of Alaska waters through 2021 and analysis of the collected datasets for cetacean density through 2022. NMFS aims to continue the PacMAPPS partnership with the Navy and BOEM beyond the current survey cycle so as to provide for a new 5-year survey schedule beginning in 2022. The SWFSC is currently (June – Dec 2018) conducting a comprehensive West Coast Survey as part of Year 2 of PacMAPPS. The PIFSC has allocated ship time for the Year 3 winter HICEAS survey focused on the main Hawaiian Islands in 2019, and PIFSC is also committed to working with BOEM and the Navy to scope a PacMAPPS Year 4 survey scheduled for the Mariana Archipelago.

While the continuance of these large, collaborative surveys is linked to congressional funding and interest from BOEM and Navy, NOAA will continue to strengthen the partnership and communicate the significant scientific and conservation benefits accrued from these joint research initiatives.

Managing stock complexes

(5) *The PSRG recommends that NMFS develop a long-needed strategy to manage stock complexes based on their biological and ecological characteristics and the risks they face individually and collectively.*

NMFS is aware that as research on marine mammal population structure advances, we can expect stock revisions to occur and/or new stocks to be designated. However, NMFS is also cognizant of the fact that our ability to comprehensively assess and manage these individual stocks is limited by funding. Consequently, there have been and will continue to be cases where we are unable to collect, in a timely manner, the data necessary to fully delineate stocks or assess them once they are delineated. Given the future outlook, we agree with the PSRG that NMFS needs to explore viable options to manage some stocks as complexes in these cases.

There are precedents to the use of stock complexes in marine resource management. In the past, the Gulf of Mexico Bay, Sound and Estuary bottlenose dolphin stocks have been grouped for the purposes of producing SARs. Similarly, in Hawaiian waters common bottlenose dolphins, spinner dolphins, pantropical spotted dolphins, and false killer whales are all reported as stock complexes in the SARs to simplify reporting (although each stock is assessed independently). Some fishery management plans group fish stocks into stock complexes. The National Standard Guidelines under the Magnuson-Stevens Fishery Conservation and Management Act provide considerations that must be met to designate fish stock complexes, including the identification of indicator stocks for each stock complex (50 CFR 600.310). NMFS will evaluate the feasibility of establishing a national strategy for identifying marine mammal stock complexes in species and regions for which individual stocks cannot be delineated or assessed in a timely manner. We will evaluate existing implementations of the stock complex concept, including those cited above, to determine their applicability given MMPA and Endangered Species Act (ESA) considerations and our ability to effectively monitor, assess, and manage these stock complexes.

Monitoring waivered activities

(6) *The PSRG recommends that NMFS monitor activities otherwise waived from certain Marine Mammal Protection Act (MMPA) statutes and regulations.*

On February 9, 2018, Congress passed the Bipartisan Budget Act of 2018 (Budget Act), Public Law 115-123, which included a requirement that the Secretary of Commerce, as delegated to the Assistant Administrator of the National Marine Fisheries Service, issue a waiver of the MMPA moratorium and prohibitions for the following projects in the Louisiana Comprehensive Master Plan for a Sustainable Coast. The Act directs that, to the extent practicable and consistent with the purposes of the projects, the State of Louisiana will minimize impacts on marine mammal species and population stocks; and monitor and evaluate the impacts of the projects on such species and population stocks.

As stated in the *Federal Register* notice announcing issuance of this waiver (83 FR 12338, March 21, 2018), for the Mid-Barataria Sediment Diversion, NMFS is a cooperating agency on the project's Environmental Impact Statement (EIS) under NEPA and a member of the Louisiana Trustees for the Deepwater Horizon Natural Resource Damage Assessment Restoration Plan. Through these roles, NMFS has been and will continue to evaluate impacts of the project on marine mammals and continue to work with the State on marine mammal monitoring. For example, NMFS, in cooperation with the State's Coastal Protection and Restoration Authority (CPRA), has developed a marine mammal science plan which includes the collection of baseline data on Barataria Bay dolphins through tagging, health assessments, and modeling. This plan was developed with internal and external marine mammal experts, as recommended by the Marine Mammal Commission, who led efforts to collect data on Barataria Bay dolphins after the Deepwater Horizon oil spill. Phase I of the science plan is partially complete and NMFS is in discussion with the CPRA on funding for Phase II. For all projects, NMFS intends to continue working with external marine mammal experts to inform development and implementation of a comprehensive marine mammal monitoring plan as part of the State's consultation requirement.

Currently, for the Mid-Barataria Sediment Diversion, the State and the U.S. Army Corps of Engineers are coordinating closely with NMFS to ensure compliance under multiple statutes other than the MMPA (*e.g.*, NEPA and the Clean Water Act), and further coordinating in consideration of the Mid-Barataria Sediment Diversion pursuant to the Deepwater Horizon restoration planning efforts. These statutes and processes include various requirements to assess, minimize, and/or monitor impacts to different resources, including marine mammals. While the State has coordinated most closely with NMFS on the Mid-Barataria Sediment Diversion to date, it is likely the other two projects covered under the waiver will be similarly coordinated with NMFS to some degree due to the NEPA processes and permitting requirements under other Federal statutes. We believe that in many cases other statutes and processes will provide the

State efficient frameworks within which to conduct the required consultation with NMFS, and we will support the State in integrating Budget Act compliance into these processes, discussions, and timelines, as needed. Regardless, NMFS is prepared to support the State in identifying and developing practicable measures to minimize and monitor impacts of the covered projects on marine mammals.

Setting priorities

(7) The PSRG recommends that NMFS place greater emphasis on prioritizing available research and management resources to ensure that its scientific and management actions are sufficient to prevent irreversible changes in stock status.

When working with limited resources, by necessity we need to prioritize our research and management activities to focus on those stocks and species that are most vulnerable, while balancing the need to collect information on and protect those populations that we know less about. One strategy we have employed to accomplish this is the Species in the Spotlight initiative, launched in 2015 as a way to marshal resources within NMFS, as well as those of vital partners, and garner greater public support to address immediate needs to help stabilize the declining populations of eight endangered species considered most at-risk of extinction, three of which are marine mammals. Our goal is to recover species to the point where they no longer need the protections of the ESA and can be removed from the list of endangered and threatened species. We developed five-year action plans, created with the involvement of local partners and stakeholders, to focus collective efforts to benefit the recovery of our Species in the Spotlight. While NMFS is working to recover all listed species under our jurisdiction, the Species in the Spotlight initiative is an example of how we are prioritizing our efforts and resources under the ESA.

The MMPA is designed to protect all marine mammals, but has special emphasis on those stocks that are most at risk. Specifically, depleted and strategic stocks. By design, the Act establishes a management framework for NMFS and FWS to focus its efforts on prioritizing those stocks. For example, interactions with strategic stocks trigger certain management actions, and some permitting and exemptions to the take moratorium are not allowed for stocks that are designated as depleted.

Outside of the explicit MMPA and ESA directives, we regularly consider stock/species status when developing annual spending plans, budget initiatives, and research plans. We also weigh how best to leverage our resources to benefit the greatest number of species (see response to comment #4). It is NMFS policy to prioritize and allocate our limited agency resources to the species we manage based on the species status, information gaps, and certainty that protective actions can be effective. We will continue to prioritize our science and conservation efforts on those stocks/species that are most at risk, and appreciate the SRG's continued input on areas of need.

False killer whales and other insular cetacean stocks

(8) *The PSRG recommends that NMFS continue a high level of funding for studies of false killer whales and their vulnerability to human-related threats in Hawaiian and other U.S. waters in the Central Pacific.*

Thank you for your recommendation. NMFS agrees that a high level of funding is desirable to support studies of false killer whales and their vulnerability to human-related threats in Hawaiian and other waters of the Central Pacific. NMFS continues to support additional studies when funding is available. Currently, NMFS is working with the False Killer Whale Take Reduction Team (FKWTRT) to explore additional research studies to reduce serious injury and mortality to false killer whales in longline fisheries and we hope to leverage funding from multiple sources to accomplish such research.

(9) *The PSRG also recommends that NMFS, in consultation with the False Killer Whale Take Reduction Team, critically examine all false killer whale interactions with the deep-set longline fishery to determine what current gear and/or techniques should be modified or whether an entirely different approach should be developed and implemented. The PSRG's 2017 letter recommended that "…the relative bending strength of different circle hook types that currently meet regulatory standards for the fishery be tested by an independent entity with results reported to NOAA and the TRT." To our knowledge, this recommendation has not been completed and we reiterate it here.*

NMFS agrees that interactions between false killer whales and the deep-set longline fishery must be critically examined, and we are closely working with the FKWTRT to reduce serious injuries and mortalities of false killer whales within this fishery. NMFS reconvened the FKWTRT in April 2018 to evaluate the status of the False Killer Whale Take Reduction Plan (Plan) particularly given new information about current hook requirements and ongoing interactions. During the meeting the FKWTRT examined details of interactions and factors that may contribute to the outcomes, including gear and handling techniques. The FKWTRT is currently considering recommendations for modifying the Plan to reduce mortality and serious injury. This includes consideration of gear modifications (*e.g.*, hook and branchline specifications) and modifications to training of the captain and crew and handling techniques during interactions. Following past recommendations from the PSRG and discussions at the recent FKWTRT meeting in April 2018, NMFS has been coordinating with the FKWTRT to develop and execute a study to examine the strength of hook types that meet regulatory standards. NMFS will continue to coordinate with the FKWTRT on changes to the Plan that reduce mortality and serious injury pursuant to the MMPA goals.

(10) *In addition, the PSRG recommends that NMFS increase its support for studies of other insular cetacean populations in U.S. waters of the central Pacific.*

NMFS continues to support surveys for insular cetaceans in Hawaii and the Mariana Archipelago, including the collection of photographs, tissue samples, and deployment of satellite tags. Survey work in the Mariana Archipelago has been conducted in partnership with the U.S. Navy, and support for future efforts there will be in part contingent on the continuation of that funding. Support for insular cetacean studies has focused primarily on identifying population structure and abundance, though in partnership with the State of Hawaii and Cascadia Research Collective, ESA Section 6 funds are also supporting dedicated work on MHI insular false killer whale movement, habitat, and overlap with nearshore hook and line fisheries. Depending on the availability of funds, NMFS hopes to further expand its support for insular cetacean research within Hawaii.

Hawaiian monk seals

(11) *The PSRG recommends that NMFS continue to provide full support for its monk seal research and management programs.*

Hawaiian monk seal research and recovery activities continues to be a high priority for NMFS. Current funding levels allow NMFS to maintain the Hawaiian Monk Seal Assessment and Recovery Camps at sufficient staffing levels and duration to maintain our long-term population data set at a quality sufficient to inform critical conservation activities. Our 2018 camps are currently deployed in the field, and our 2019 field season is fully funded. NMFS is also undertaking multiple research and management objectives in the MHI including working with partners to reduce the risk of State fisheries, toxoplasmosis, and increase seal vaccinations, to name a few. Recently, NMFS approved a new ESA Section 6 grant for the State of Hawaii to continue and expand their monk seal related outreach efforts throughout the state.

(12) *The PSRG also recommends that NMFS reinvigorate its efforts to clear the Northwestern Hawaiian Islands of net debris.*

The PIFSC will be undertaking a large-scale marine debris removal effort in the fall of 2018 focusing effort at some critical monk seal haul-out and foraging areas in the NWHI. PIFSC debris clean-up efforts rely on support from multiple NOAA programs (*e.g.*, NOAA Marine Debris Program, Papahanaumokuakea Marine National Monument, etc.) and other partners. Funding for debris clean-up efforts and ship time has decreased in recent years; however, PIFSC will continue to work with its many partners to find ways to direct resources towards debris removal efforts in the NWHI.

Spinner dolphins

(13) *The PSRG recommends that NMFS support development and implementation of a spinner dolphin survey design that provides a stronger basis for characterizing the abundance, trend, and status of spinner dolphins around the island of Hawaii.*

NMFS will be convening a workshop in 2019 to discuss research needs and to develop and prioritize research projects for Hawaii's spinner dolphins. This will include the development and evaluation of survey designs to characterize abundance and trends. The workshop and subsequent plan will focus on populations of spinners across the main Hawaiian Islands and not focus exclusively on Hawaii Island populations.

(14) *The PSRG also recommends that NMFS reconsider plans to manage human interactions with spinner dolphins by establishing 50-yard approach limits, and instead focus on restrictions based on time and area management.*

NMFS sought public comments on its proposed rule and draft Environmental Impact Statement, which analyzed alternatives for 50-yard approach limits as well as mandatory time-area closures for Hawaiian spinner dolphins. We continue to evaluate comments received. In the interim, NMFS continues to work with its partners and tour operators to manage human interactions and promote the Dolphin SMART program.

Humpback, blue, and gray whales

(15) *The PSRG recommends that NMFS convene a take reduction team for fisheries that are known to entangle humpback whales along the West Coast and also evaluate the large number of entanglements to determine if they constitute an unusual mortality event.*

The entanglement of large whales, including humpback whales, along the west coast remains a significant concern to the agency and one for which the West Coast Region (WCR) has dedicated significant time and resources to address. The WCR and the Southwest and Northwest Fisheries Science Centers have engaged in a variety of efforts primarily to develop approaches to avoid or significantly reduce the number of large whale entanglements, but also in anticipation of regulatory needs such as evaluating and authorizing incidental take of ESA-listed species and MMPA stocks. These efforts improve our understanding of the driving factors influencing entanglement risk and the development of predictive tools to assess entanglement risk and provide a foundation for fishery management responses. In addition, the WCR has worked with the State of California and engaged fishermen to understand the nature and scale of the State fisheries entangling large whales. Some initial discussions have also occurred pertinent to State-managed fisheries off Washington and Oregon.

Section 118(f)(3) of the MMPA provides that NMFS may prioritize convening take reduction teams and developing take reduction plans (TRPs) when insufficient funding is available. MMPA section 118(f)(3) contains specific priorities for developing TRPs. NMFS has insufficient funding available to simultaneously develop and implement TRPs for all strategic stocks that interact with Category I or Category II fisheries. As provided in MMPA section 118(f)(6)(A) and (f)(7), NMFS uses the most recent SAR and LOF as the basis to determine its priorities for establishing TRTs and developing TRPs. Through this process for developing TRTs, in 2015, NMFS evaluated the CA/OR/WA stock of humpback whales and the WA/OR/CA sablefish pot fishery and identified it as a lower priority compared to other marine mammal stocks and fisheries for establishing TRTs, based on population trends of the stock and M/SI levels incidental to that commercial fishery. In addition, NMFS continues to collect data to categorize fixed gear fisheries and assess their risk to large whales off the U.S. west coast. Accordingly, given these factors and NMFS' priorities, implementation of developing a TRP for the WA/OR/CA sablefish pot trap fishery and other similar Category II fisheries has been deferred under section 118 as other stocks/fisheries are a higher priority for any available funding for establishing new TRPs.

Since 2015, NMFS has acquired additional information about the fisheries entangling these stocks, particularly the California Dungeness crab pot/trap fishery. Given such new information and the efforts described above, NMFS is in the process of reevaluating these priorities. We will update the SRG on any changes for large whales off the West Coast after that analysis is completed. In the meantime, NMFS will continue to gather fishery characterization and entanglement information for these fisheries in anticipation of either convening a take reduction team in the future as resources and priorities allow, or through other regulatory mechanisms to minimize incidental take and serious injury and mortality levels to both the current MMPA stock and the two newly listed distinct population segments (DPSs) of humpback whales. This information would be critical to the development of a take reduction plan to reduce bycatch of strategic stocks, particularly given the tight regulatory timeframe required under the MMPA.

Under the MMPA, an unusual mortality event (UME) is defined as "a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response." NMFS has identified seven criteria to aid in the decision as to whether an increase in morbidity, mortality, or strandings may qualify as a UME. NMFS does not consider the recent increases in entanglement events as qualifying as a UME for several reasons. While the causes of the increases are under investigation, the primary causal factors in increases in entanglement risk include the amount or degree of overlap between foraging and migrating whales and the effort levels and location of the fisheries. Increased public awareness of the issue has also likely led to an increase in reports of animals, complicating our ability to determine whether the rate of entanglements has truly spiked in just the last few years. Further, the ultimate purpose of the UME designation is to direct resources towards understanding the cause of the event and possibly describing responses to help minimize the impact to the population. NMFS is already directing resources towards understanding and addressing the issue and declines to add further burden to the UME teams and funds already addressing other significant UMEs with unknown causes.

(16) *The PSRG recommends that NMFS reconsider the characteristics and status of the Pacific Coast Feeding Group (PCFG) of gray whales and whether it should be recognized and managed as a full stock.*

We do not believe that currently available information supports classifying the PCFG as a "full stock" under the MMPA. As noted in the SRG's comments, we convened a NMFS Task Force and workshop in 2012 to, among other things, review the available photo-identification, genetic, and tagging data for North Pacific gray whales, including the PCFG. The report of the workshop states "there remains a substantial level of uncertainty in the strength of the lines of evidence supporting demographic independence of the PCFG" and that additional research is needed to better identify recruitment levels into the PCFG and further assess the stock status of PCFG whales (Weller *et al.*, 2013). Consequently, the Task Force was unable to provide definitive advice as to whether the PCFG is a population stock under the MMPA and the GAMMS. The Task Force report was reviewed during the SAR process which, since 2012, has continued to result in NMFS finding that the PCFG is a feeding group that "may warrant consideration as a distinct stock in the future."

Since that 2012 Task Force assessment, NMFS scientists have kept apprised of new information pertaining to the PCFG and been actively engaged in field studies and gray whale assessments/workshops, including authoring scientific studies pertaining to the PCFG. Notably, since 2014 NMFS scientists have participated in a series of four workshops convened by the IWC to review the range-wide status and structure of North Pacific gray whales (IWC, 2014; 2015; 2016; 2017). Those workshops reviewed the best available information, including the latest information regarding abundance, distribution, genetics, recruitment, mixing rates and human-caused mortality of PCFG whales. A fifth and final workshop held in March 2018 (IWC, 2018) culminated in the identification of two plausible scenarios for North Pacific gray whale stock structure. Neither scenario conflicts with NMFS' current characterization in the SAR of a single Eastern North Pacific (ENP) gray whale stock that includes the PCFG. Moreover, the IWC continues to refer to the PCFG as a feeding "aggregation" or "group" within the eastern breeding stock of gray whales (IWC, 2018).

Also, we are aware that the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recently split ENP gray whales into two populations - a "North Pacific Migratory population" (designated Not at risk) and a "Pacific Coast Feeding Group population" (designated as Endangered because it is just below the threshold of 250 mature individuals; COSEWIC, in press). An earlier COSEWIC review in 2004 determined that the PCFG was a small part of the ENP population and not a "designatable unit." The more recent decision to split the ENP population relies on genetic and photo-identification evidence reported since that time and which allows the PCFG to be assessed against the COSEWIC discreteness and significance criteria and not MMPA requirements. Much of the information supporting the decision to split the ENP population has been reviewed by the NMFS Task Force and by NMFS scientists participating in the workshops (noted above). In its review, the COSEWIC notes the uncertainties in determining whether the PCFG is demographically discrete and acknowledges that the primary difference between the two 'populations' is largely behavioral (*i.e.*, selection of different feeding areas) with limited evidence of genetic distinctness. These findings are consistent with the NMFS Task Force findings and with our current findings in the SAR pursuant to the MMPA. We will continue to evaluate any new information bearing on the stock structure of North Pacific gray whales through the SAR process and in accordance with our GAMMS.

(17) Finally, the PSRG requests that in future years NMFS provide the PSRG information on how it is achieving the MMPA directive to NMFS to "ban the importation of commercial fish or products from fish which have been caught with commercial fishing technology which results in the incidental kill or incidental serious injury of ocean mammals in excess of United States standards."

In August 2016, NOAA Fisheries published the MMPA Import Provisions Rule, which established the criteria for evaluating a nation's regulatory program for reducing marine mammal bycatch and the procedures required to receive authorization to import fish and fish products into the United States. The MMPA Import Provisions Rule aims to reduce marine mammal bycatch associated with international commercial fishing operations by requiring fish and fish products imported into the United States to be held to the same standards as U.S. commercial fishing operations. Under this rule, fish and fish products from fisheries identified by the Assistant Administrator in the List of Foreign Fisheries can only be imported into the United States if the harvesting nation has applied for and received a comparability finding from NMFS. The rule establishes procedures that a harvesting nation must follow and conditions to meet, to receive a comparability finding for a fishery. NMFS appreciates the SRG's interest in this issue and will provide periodic updates to the group on our implementation progress.

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