HONORABLE GEORGE J. JORDAN
ADMINISTRATIVE LAW JUDGE

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**	Docket No. 19-NMFS-0001 RIN: 0648-BI58 and RIN: 0648-XG584

THIRD DECLARATION OF CHRIS YATES

I, Chris Yates, declare as follows:

1. I am the Assistant Regional Administrator for Protected Resources for the West Coast Region of the National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA). I previously filed declarations in this matter dated April 5, 2019 and May 15, 2019. I incorporate by reference paragraphs 1 through 5 of my April 5, 2019 declaration, which explain my position and qualifications relative to this matter.

2. I have reviewed the Announcement of Hearing and Final Agenda Regarding Proposed Waiver and Regulations Governing the Taking of Marine Mammals issued by Judge Jordan for this matter (84 Fed. Reg. 30,088 (2019), hereafter Final Hearing Agenda), as well as the following declarations filed by other parties: Declaration of DJ Schubert dated May 20, 2019, submitted by the Animal Welfare Institute (AWI); Declaration of Jonathan Scordino dated May 15, 2019, Declaration of Greig Arnold dated May 16, 2019, Declaration of Patrick DePoe dated May 15, 2019, Declaration Polly DeBari dated May 13, 2019, Declaration of Daniel J.

Greene, Sr., dated May 14, 2019, Declaration of Maria Pascua dated May 13, 2019, and Declaration of Joshua L. Reid, Ph.D. dated May 16, 2019, submitted by the Makah Indian Tribe; Declaration of Margaret Owens dated May 17, 2019, submitted by Peninsula Citizens for the Protection of Whales (PCPW); and Declaration of Brett Sommermeyer dated May 20, 2019, submitted by Sea Shepherd Legal and Sea Shepherd Conservation Society (collectively, Sea Shepherd).

3. I prepared this declaration to respond to information provided in the parties' declarations referenced above and in support of NMFS's proposed waiver and regulations. Except as otherwise stated below, my declaration is organized in accordance with the list of Issues to Be Addressed at the Hearing as identified in the Final Hearing Agenda for this matter (84 Fed. Reg. at 30,089).

4. One issue identified in the Final Hearing Agenda does not fall within any of the enumerated factors for issuance of a waiver and regulations under the Marine Mammal Protection Act (16 U.S.C. §§ 1361 *et seq.*) (MMPA). This is Issue II.A.2(a) – "What is the relevance in this proceeding of the Treaty of Neah Bay, between the Makah Tribe and the United States, which explicitly protects the tribe's right to hunt whales?" 84 Fed. Reg. 30,090. NMFS does not interpret the requirement of MMPA section 103(b)(2), which relates to "international" treaty obligations of the United States, as applying to treaties between the United States and Native American tribes. NMFS acknowledges and respects the Tribe's treaty right but did not rely on the treaty right in evaluating whether the proposed waiver and regulations satisfy MMPA standards.

REQUIREMENTS FOR WAIVER

ENP GRAY WHALE STOCK DISTRIBUTION AND ABUNDANCE

5. Issue I.A.1(a) in the Final Hearing Agenda, which relates to the requirements for granting a waiver under section 101(a)(3)(A) of the MMPA, asks what numbers represent the best available scientific information regarding the carrying capacity, abundance, status and trends, and optimum sustainable population (OSP) levels for the eastern North Pacific (ENP) and western North Pacific (WNP) stocks of gray whales, as well as for the Pacific Coast Feeding Group (PCFG), which is a component of the ENP stock. To clarify, NMFS interprets the legal requirement on which this issue of fact is premised as applying to the stock for which the waiver is proposed. *See* 16 U.S.C. § 1371(a)(3)(A) (authorizing the Secretary to waive the MMPA requirements and allow the taking "of any marine mammal," provided that the Secretary "hav[e] due regard to the distribution, abundance, breeding habits, and times and lines of migratory movements of *such* marine mammals.") (emphasis added). Here, NMFS is proposing a waiver only for the ENP gray whale stock and therefore believes that the relevant inquiry under section 101(a)(3)(A) is whether NMFS's proposed waiver gives due regard to the ENP stock's abundance and distribution. The best available scientific information regarding the ENP stock's status, historical fluctuations and trends, carrying capacity, potential biological removal (PBR), and abundance in relation to OSP levels is contained in NMFS's recently-released 2018 Stock Assessment Report (SAR) for the ENP stock, attached as Exhibit 2-12 to the Second Declaration of Dr. Shannon Bettridge (filed herewith). The information in the 2018 SAR is consistent with the data provided in NMFS's initial direct testimony submitted in this matter. Bettridge Decl. ¶ 23; Second Bettridge Decl. ¶¶ 4-5.

6. Although the "due regard" requirement in MMPA section 101(a)(3)(A) only applies to the ENP gray whale stock, NMFS fully evaluated possible effects of the proposed waiver to the WNP stock and to the PCFG. With respect to the PCFG, NMFS evaluated whether

the proposed waiver would reduce PCFG abundance and thereby affect the distribution of the ENP stock within the PCFG range. *See* 84 Fed. Reg. 13,604, 13,608-09, 13,611-12 (2019) (NMFS's Proposed Rule for this matter, describing NMFS's findings regarding effects of the waiver to the PCFG). For the WNP stock, NMFS considered, as an additional relevant factor in developing the proposed regulations, whether the regulations were necessary and appropriate to limit the risk of death, injury, or harm to WNP gray whales and included a number of protections to reduce these risks. *See* Proposed Rule, 84 Fed. Reg. at 13,614. I therefore address risks to WNP whales in the section below regarding Requirements for Regulations, Other Factors.

7. As explained in my April 5, 2019 declaration, although the best available scientific evidence does not support recognizing the PCFG as a separate stock at this time, NMFS will continue to monitor this issue and has taken the precautionary approach of including a number of restrictions in the proposed regulations to protect the PCFG. Yates Decl. ¶¶ 23, 26-30, 32-42. The best available evidence regarding the PCFG's status, historical fluctuations and trends, an informational PBR, and current abundance is contained in the 2018 ENP gray whale SAR and is consistent with the information provided in NMFS's initial direct testimony. *See* Bettridge Decl. ¶ 24; Second Bettridge Decl. ¶ 6.

8. Paragraphs 40 and 41 of Mr. Schubert's Declaration assert that designating the PCFG as an MMPA stock could result in a finding of depleted status under the MMPA and that the PCFG are not within OSP. Because the PCFG currently does not meet the MMPA definition of a "stock," there is no basis for determining the group's OSP levels or designating the group as "depleted." The MMPA defines OSP "with respect to any population stock," and does not provide for making OSP determinations for subgroupings below the stock level. *See* 16 U.S.C. § 1362(9). Likewise, under the MMPA, NMFS can only designate marine mammals as "depleted"

at the species or stock level. *See* 16 U.S.C. § 1362(1). Per the MMPA, species or stocks that are listed as threatened or endangered under the Endangered Species Act (ESA) are automatically considered depleted, but for non ESA-listed stocks, NMFS must undertake rulemaking in order to designate a stock as "depleted." *See* 16 U.S.C. §§ 1362(1)(A), (C), 1383b). In our Proposed Rule, we explain that, due to uncertainties in population parameters such as emigration and immigration rates, bycatch mortality, and recruitment, NMFS does not have sufficient information to determine whether the PCFG, if it were a stock, would be within OSP levels. Proposed Rule, 84 Fed. Reg. at 13,604; *see also* Second Declaration of Dr. Jeffrey Moore ¶¶ 3-4.

9. My first declaration explains the protective measures contained in the proposed regulations to ensure that the waiver does not cause PCFG abundance to drop below recent stable levels. Yates Decl. ¶¶ 27-45. One of these protections is the use of low-abundance triggers that would stop the hunt if the PCFG abundance estimate fell below 192 animals or the associated minimum abundance estimate dropped below 171 whales. *Id.* ¶ 37; *see also* Bettridge Decl. ¶ 5 (explaining minimum abundance estimates, or "Nmin"). Paragraphs 66 and 89 of Mr. Schubert's declaration state that "NMFS has not provided an explanation as to its selection of 192 as a low abundance trigger for PCFG gray whales" and also expresses confusion as to why the associated trigger of 171 animals, based on the PCFG's minimum population estimate, is necessary. Our Proposed Rule explains the reasoning behind the low abundance triggers and the values we selected. *See* Proposed Rule, 84 Fed. Reg. at 13,609. Also, Mr. Schubert mischaracterizes the Nmin trigger. As described in the Second Declaration of Dr. Jeffrey Moore, Nmin is not simply "calculated from" the point estimate. *See* Second Moore Decl. ¶ 6. Rather, it can vary based on the degree of confidence in the point estimate. The lower the confidence in the point estimate, the wider the error bands and the lower the Nmin. The use of the Nmin as an additional trigger

is precautionary to account for situations in which, for example, sampling effort is reduced. The choice of the two thresholds is based on the management goal of maintaining summer-feeding gray whales in the PCFG feeding area. The number of 192 is the lowest level that was seen during the period of recent stable abundance and represents an abundance level from which the PCFG was able to grow to its present abundance of more than 240 animals, and 171 is the Nmin (20^{th} percentile of the log-normal distribution) associated with that abundance estimate. *See* Proposed Rule, 84 Fed. Reg. at 13,609.

10. Paragraph 91 of Mr. Schubert's declaration asserts that NMFS has not disclosed whether threats in the PCFG range have increased or become more severe in recent years. I disagree with this statement. NMFS's 2015 DEIS[1] describes the full range of threats to the PCFG throughout its range. 2015 DEIS Ch. 5. The Second Declaration of Dr. David Weller further describes recent PCFG abundance trends and their relevance. *See* Second Weller Decl. ¶¶ 26-28, 53-39.

11. Issue I.A.1(d) from the Final Hearing Agenda pertains to whether the ENP stock's carrying capacity in the summer feeding areas is being reduced and whether this issue merits further consideration before a waiver may be granted. *See* Schubert Decl. ¶¶ 27-30. Dr. Weller's Second Declaration addresses the question regarding carrying capacity. I note that NMFS did consider the likely effects of climate change on the status of ENP gray whales in the 2015 DEIS (Section 3.4.3.6.11, Climate Change and Ocean Acidification) and in the SARs (NMFS Ex. 2-6 (Carretta *et al*. 2015), NMFS Ex. 2-7 (Carretta *et al.* 2017), NMFS Ex. 2-12 (Carretta *et al*. 2019). The proposed rule summarizes the conclusion in the SAR: "The SAR does

[1] Per NMFS's regulations at 50 C.F.R. § 228.16(b), the 2015 DEIS will be introduced into evidence at the commencement of the hearing for this matter. *See* Yates Decl. ¶ 12.

not indicate that these factors are a threat to the OSP status of the ENP stock at this time." Proposed Rule, 84 Fed. Reg. at 13,607. Also, in part to ensure that NMFS's authorization of a tribal hunt continues to reflect the best available scientific information regarding the ENP stock's carrying capacity and abundance, and to account for future uncertainties related to ocean conditions, NMFS limited the proposed waiver to a 10-year period. Given the limited waiver period and the extremely low level of hunting that would be allowed under the proposed waiver, NMFS does not believe that additional analysis is warranted at this time.

12. Issue I.A.3(c)(iv) pertains to the number of whales likely to be subjected to hunting or training activities under the proposed regulations.[2] My first declaration describes the limits contained in the proposed regulations on the number of strikes, unsuccessful strike attempts, approaches, and training activities. *See* Yates Decl. ¶¶ 27-45. We cannot calculate the number of individual whales that would be affected, because the same whale could be subject to more than one approach over the 10-year waiver period. We did evaluate the likely effects of hunting and training activities on ENP, PCFG, and WNP whales and determined that such effects would be minimal. *See, e.g.*, Yates Decl. ¶¶ 46-70; Weller Decl. ¶¶ 38-66; Proposed Rule, 84 Fed. Reg. at 13,611-15.

13. Paragraphs 59 through 63 of Mr. Sommermeyer's declaration assert that authorization of a Makah gray whale hunt would "set a dangerous precedent" and potentially encourage other tribes to request authorization to hunt for whales. Mr. Sommermeyer does not identify any provision in the MMPA that requires NMFS to speculate about the potential for

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[2] The Final Hearing Agenda lodges this issue under the factor for the ENP stock's times and lines of migratory movements, however, we considered the effects of hunt activities primarily as effects to the stock's abundance and distribution.

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other tribes to request a waiver in making a final decision on the proposed waiver and regulations. NMFS did evaluate this topic in the 2015 DEIS. 2015 DEIS Section 4.17, Regulatory Environment Governing Harvest of Marine Mammals. I note that any future MMPA waiver would be subject to the MMPA's formal rulemaking process and, if the waiver involved hunting whales, to all applicable procedures under the International Convention for the Regulation of Whaling and the Whaling Convention Act.

14. Mr. Schubert's declaration in several places raises the issue of the welfare of individual whales that may be affected by hunt activities. *E.g.* Schubert Decl. ¶¶ 81, 84, 85, 94. It appears that Mr. Schubert's allegations concern NMFS's analysis in the 2015 DEIS and not the proposed waiver. To clarify and as discussed above, under the MMPA the proposed waiver and regulations apply at the level of the ENP stock, therefore consideration of potential effects to individual animals is not relevant to the MMPA standards applicable to this proceeding. The proposed regulations do include provisions to ensure that any hunt is carried out in a humane manner based on the best available scientific information. *See* Proposed Rule, 84 Fed. Reg. at 13,606, 13,610; Proposed Regulations §§ 216.113(a)(7)(i), .116(a)(2), .117(b).

ENP GRAY WHALE STOCK BREEDING HABITS

15. Final Hearing Agenda Issue I.A.2(a)(ii), which relates to effects of the proposed waiver on gray whale breeding habits, asks whether the proposed hunt will adversely affect ENP gray whale mothers and calves. NMFS considered potential effects to cow/calf pairs as part of our overall evaluation of potential effects to ENP stock abundance and, given the IWC's prohibition on striking, taking, or killing calves or whales accompanying a calf, included the following prohibition in the proposed regulations: "(a) It is unlawful for the Makah Indian Tribe or any enrolled Makah Indian tribal member to: . . . (6) Hunt or make a training harpoon throw

on a calf or an adult gray whale accompanying a calf." Proposed Regulations § 216.115(a)(6). We believe that this prohibition will provide sufficient protection to ensure that calves and cow/calf pairs are not targeted by the hunt.

TIMES AND LINES OF MIGRATORY MOVEMENTS

16. Issue I.A.3(c)(ii) addresses the proportion of the ENP stock's migratory range included within the proposed hunt area. The coastal migratory corridor from Baja California to the Bering Sea is approximately 6,000 km (~3,700 miles) long. NMFS Ex. 1-19, at 13 (Nerini 1984). The greatest north-south dimension of the proposed hunt area is approximately 53 km (~33 miles) meaning the hunt area is less than one percent of the lineal distance of the migratory corridor. NMFS Ex. 1-7, at 6, 30; *see* NMFS Ex. 1-20 (NMFS 2019e).

MARINE ECOSYSTEM EFFECTS

17. Issue I.B.1(a) questions whether the northern California Current ecosystem rather than a smaller area, such as the Makah U&A, is "the appropriate ecosystem to focus on for its proceeding." 84 Fed. Reg. at 30,089. This issue appears to relate to Mr. Schubert's allegation that "NMFS defines the geographic area of its analysis as the northern California Current ecosystem." Schubert Decl. ¶ 47; *see also id.* ¶ 97. Mr. Schubert goes on to assert that it is "farcical to use that larger range for the purpose of determining the hunt's potential impact on the role of gray whales in the ecosystem." *Id.* ¶ 47. NMFS disagrees with Mr. Schubert's characterizations and statements for several reasons, as explained in paragraphs 18-20 below.

18. First, NMFS did not focus its entire waiver analysis for this proceeding solely on effects within the northern California Current ecosystem. For purposes of evaluating effects of the waiver on the ENP stock generally and on PCFG abundance and distribution within the summer feeding area, NMFS considered the potential for effects at all relevant scales, from

range-wide to within the Makah U&A. *See, e.g.*, Weller Decl. ¶¶ 40, 59, 71-73 (the proposed waiver would have no discernable effect on ENP stock abundance or rate of growth, no meaningful effect on the distribution of the ENP stock within the PCFG range, and is unlikely to affect the health or stability of the marine ecosystem at any relevant scale, including the scale of the hunt area). NMFS identified the northern California Current ecosystem only for purposes of addressing the specific MMPA requirement that NMFS evaluate consistency of the waiver with the MMPA's goal of maintaining the health and stability of the marine ecosystem and marine mammals as significant functioning elements of their ecosystem. *See* 16 U.S.C. § 1361.

19. Second, Mr. Schubert does not identify any scientific literature supporting the identification of the Makah U&A as a separate marine ecosystem. Rather, Mr. Schubert refers to the legal opinion in the case *Anderson v. Evans*, which related to the appropriate scale for analysis under NEPA, not under MMPA section 101(a)(3)(A). *See Anderson v. Evans*, 371 F.3d 475, 492-92 (9th Cir. 2004). As explained in the first Weller declaration, the northern California Current ecosystem is the smallest recognized marine ecosystem in the scientific literature, therefore evaluation at that scale for the specific purpose of consistency with the MMPA's purposes and policies, using the best scientific information available, is appropriate. *See* Weller Decl. ¶ 68.

20. Finally, as noted above, although not a separate ecosystem, NMFS did consider whether the proposed waiver would affect the marine environment at the scale of the northern Washington coast and the Makah U&A and determined that, because these areas are shaped by large-scale dynamic processes, because the role of ENP gray whales in structuring these habitats is limited, and because of the limited nature of the impacts of the proposed hunt, the proposed waiver would not have a significant effect on the health or functioning of the marine

environment at any relevant scale. *See* Proposed Rule, 84 Fed. Reg. at 13,613; Weller Decl. ¶¶ 71-72.

21. Final Hearing Agenda Issue I.B.1(b)(ii) questions whether the environmental role and impact of whales feeding within the Makah U&A require separate consideration under the MMPA. As explained in paragraphs 18-20 above, NMFS did consider this issue in concluding that the proposed waiver satisfies MMPA requirements. NMFS also considered possible environmental effects of the proposed waiver within the hunt area in our 2015 DEIS and concluded that with respect to the physical features and dynamic processes of the area, none of the alternatives would have appreciable effects at any scale. 2015 DEIS Section 4.3, Marine Habitat and Species. The analysis therefore focused on potential effects on benthic and pelagic biological resources of the marine habitat. With respect to those resources, the DEIS concluded: "The abundance, recruitment, distribution, and variation in marine species and communities in the project area strongly reflect the underlying physical environment" and that "in the context of this energetic and dynamic environment," none of the alternatives "has the potential to appreciably affect pelagic or benthic habitats or the associated organisms and communities." DEIS Section 4.3.3, Evaluation of Alternatives. We do not believe that any additional evaluation is needed under the MMPA at this time.

22. Issue I.B.1(b)(iii) also pertains to effects of the proposed waiver on the ENP stock's ecosystems. I explain above in paragraph 16 that the proposed hunt area represents less than one percent of the stock's entire range. Due to the small size of the hunt area, we do not expect any effects to be discernable at the scale of the entire migratory range. *See, e.g.,* Weller Decl. ¶¶ 67-73; NMFS Ex. 1-20 (NMFS 2019e). This issue also asks whether effects on the ENP stock as a whole should be compared and contrasted to the effects on the PCFG stock as a

subset. Because the subheading under Issue I.B.1(b) relates to ecosystem effects, we understand this question to refer to effects on the ecosystem within the PCFG range versus the entire range of the ENP stock. This is the area NMFS analyzed in its proposed waiver decision. Analysis at a smaller scale is not required under the MMPA.

<u>REQUIREMENTS FOR REGULATIONS</u>

MARINE ECOSYSTEM / RELATED ENVIRONMENTAL CONSIDERATIONS

23. Paragraph 30 of Mr. Schubert's declaration asserts that NMFS's cumulative impacts analysis in the 2015 DEIS is insufficient. I note that NMFS compliance with NEPA is not at issue at this stage of NMFS's decision-making process or in this MMPA hearing. To the extent Mr. Schubert is challenging NMFS's compliance with the MMPA (see Final Hearing Agenda, Issue II.A.3(b)), NMFS disagrees that our analysis is deficient or that additional analysis is required. Mr. Schubert does not identify any applicable MMPA provision mandating a cumulative impacts analysis. Our MMPA analysis included a thorough evaluation of gray whale historical and current abundance and trends and growth rates based on long-term data sets, as well as past, current, and anticipated future threats to the populations. Also, we evaluated the anticipated effects of the proposed regulations in the context of the ENP and WNP stocks' PBR levels. PBR is a long-term management tool, where we assume that if removals equal PBR, the population size will move toward and eventually equilibrate at maximum net productivity level (MNPL), assuming that carrying capacity is fixed, population dynamics are not stochastic, etc. If removals perennially exceed PBR, that population size will eventually become depleted to some level below MNPL, and thus below OSP. *See* Bettridge Decl. ¶ 5; Moore Decl. ¶ 8. Under NMFS's proposed waiver, any hunt impacts to the populations will be relatively small and ephemeral. Taking "too many" whales per year for decades would a problem, but taking too

many for a few years would not. Here, the effects of the proposed regulations, which would allow the removal of 25 whales over 10 years out of a population that has numbered over 20,000 animals for the past 10 years, would be so miniscule that it is unlikely those effects would be amplified by the effects of other actions. Mr. Schubert's declaration offers no new information or analysis to suggest a contrary conclusion.

ECONOMIC AND TECHNOLOGICAL FEASIBILITY

24. Mr. Schubert argues that NMFS has not provided any information about the logistics of the photo-identification process or disclosed the cost of the program, the source of funding, and the availability of funding long-term to support the program including the maintenance of the catalogs. Schubert Decl. ¶ 86. I disagree with this statement. In the Proposed Rule, we provide information on the logistics of the photo-identification process, including plans to develop a contractual mechanism with Cascadia Research Collective or in-house expertise prior to issuing permits to ensure adequate catalogs for PCFG and WNP whales are maintained and matches can be quickly made. Proposed Rule, 84 Fed. Reg. at 13,611. The Proposed Rule cited to the NMFS Protocol for Identifying Gray Whale Encountered in Makah Hunts, which describes the requirements for adequate catalogs for photo- and genetic identification processes. 84 Fed. Reg. at 13,511; Yates Decl. ¶ 34; NMFS Ex. 1-9 (NMFS 2019b). In my first declaration, I also described the NMFS Protocol for Monitoring Makah Gray Whale Hunts, which provides additional information regarding the collection of data, including photos and genetic samples, during the hunts. Yates Decl. ¶ 45; NMFS Ex. 1-12 (NMFS 2018). In addition, as summarized in the Proposed Rule, the 2015 DEIS analyzes the economic cost of hunt management and law enforcement, including continuation of longstanding whale survey and photo-identification work, with additional funding of approximately $2,000 per day of hunt

needed to support NMFS's monitoring and enforcement personnel. The annual NMFS budget for marine mammal management in the West Coast Region is over $700,000, so such costs are feasible to obtain and are not expected to affect NMFS's ability to regulate a hunt. *See* Proposed Rule, 84 Fed. Reg. at 13,614; 2015 DEIS Section 4.6.2.5.

OTHER FACTORS / EFFECTS TO WNP GRAY WHALES

25. As explained in my first declaration and in the declarations of Dr. Bettridge, based on the best available scientific evidence and the requirements of MMPA section 117, NMFS currently recognizes two stocks of gray whales, the ENP stock and the WNP stock. Yates Decl. ¶ 7; Bettridge Decl. ¶¶ 14-17; Second Bettridge Decl. ¶¶ 4, 6. NMFS does not recognize a "Western Feeding Group" of whales as a component of the ENP gray whale stock. *See* Second Bettridge Decl. ¶ 7. NMFS currently recognizes the so-called "Western Feeding Group" as part of the WNP stock. *See* Second Weller Decl. ¶ 30-31, 34.

26. NMFS is not proposing a waiver for the WNP stock. However, because the WNP stock is designated as "depleted" due to its endangered status under the ESA and there is a slight risk of Makah hunters encountering a WNP whale, NMFS carefully considered the potential effects of the proposed regulations to WNP gray whales as an additional relevant factor under MMPA section 103(b). *See* Proposed Rule, 84 Fed. Reg. at 13,614-15

27. As discussed in the second declarations of Dr. Bettridge and Dr. Weller, the best available abundance estimate for the WNP stock is currently 290. Second Bettridge Decl. ¶ 7; Second Weller Decl. ¶ 30. NMFS currently does not have sufficient information to calculate carrying capacity or OSP levels for the WNP stock and it is not necessary for this proceeding, because NMFS is not proposing to waive the MMPA take moratorium with respect to WNP whales.

28. Final Hearing Agenda Issue I.B.1(d)(iv) pertains to whether an incidental take permit under the ESA will be required to account for the possibility of a WNP whale being taken in the course of a hunt for ENP gray whales. NMFS believes the issue of ESA compliance is premature and not relevant to this proceeding, which is concerned with whether the proposed waiver and regulations satisfy the requirements of the MMPA. In any event, NMFS will carry out consultation under ESA section 7(a)(2) prior to making a final decision whether to issue a waiver and regulations. *See* 16 U.S.C. § 1536(7)(a)(2); Proposed Rule, 84 Fed. Reg. at 13,615, 13,617.

29. Paragraph 60 of Mr. Schubert's declaration asserts that all activities associated with the proposed hunt, including striking a whale, unsuccessful strike attempts, training approaches, and training harpoon throws constitute a "take" as defined under the MMPA and therefore if any of these activities affect a WNP whale, then the hunters would be in violation of the MMPA. Mr. Schubert's assertion is not completely accurate. NMFS agrees that striking a WNP gray whale would constitute a "take" and both evaluated the risk of such an event and included restrictions in the proposed regulations to limit the likelihood of its occurrence. *See* Proposed Rule, 84 Fed. Reg. at 13,608; Proposed Regulations § 216.113(a)(4)(iii). Unsuccessful strike attempts and approaches may or may not constitute a "take," depending on the nature of the event and whether it causes a disruption of the subject whale's behavior. *See* Proposed Rule, 84 Fed. Reg. at 13,615. Our proposed regulations provide that NMFS may require the Makah Tribe to obtain authorization under the MMPA for incidental take of WNP gray whales prior to issuance of a hunt permit if appropriate. *See* Proposed Rule, 84 Fed. Reg. at 13,614; Proposed Regulations § 216.113(a)(7)(vii).

OTHER FACTORS /ANDERSON v. EVANS

30. Several parties have argued that NMFS has not sufficiently analyzed the hunt under the Ninth Circuit's holding in the case *Anderson v. Evans*. *See, e.g.*, Schubert Decl. ¶ 47; Owens Decl. ¶ 6; Final Hearing Agenda Issues II.A.3(c), II.A.6(a). The *Anderson v. Evans* case is not applicable to this proceeding, because the Court's holding and related discussion of the need to evaluate local impacts were based on the requirements of NEPA, not the requirements of the MMPA. *Anderson*, 371 F.3d at 486-94. NMFS is aware of the need to ensure that any final agency action regarding the proposed waiver and regulations complies with all applicable NEPA requirements.

PROPOSED REGULATORY RESTRICTIONS

31. The proposed regulations include a definition of "hunt" and "hunting," but do not include a definition of "whaling." Mr. Schubert argues that NMFS should explain why it chose to include definitions for "hunt" and "hunting" but did not incorporate an existing regulatory definition of "whaling" under the WCA. Schubert Decl. ¶ 55. Mr. Schubert, however, does not explain why a definition of "whaling" is required under the MMPA or argue that NMFS's lack of such a definition in the proposed regulations violates any MMPA requirement. The WCA defines "whaling" to include possession of whale products. NMFS determined it would be clearer and more appropriate to separately define, for purposes of the proposed waiver, hunt activities and activities governing the use of whale products. The proposed regulations incorporate by reference the definitions contained the MMPA, but do not incorporate by reference the separate definitions contained in the WCA and its implementing regulations.

32. Mr. Schubert states that NMFS did not provide any explanation in the regulatory or preambulatory text about whether it would impose any restrictions on where the Makah tribal

members can land a dead whale. Schubert Decl. ¶¶ 55, 68. NMFS did not consider it necessary or appropriate to include provisions in the regulations regarding where the tribe may land dead whales. Where the Tribe may land whales outside of their reservation will depend on a variety of factors such as where a whale is killed, safety concerns associated with weather and sea conditions, and whether the Tribe requires or has obtained permission from affected land owners or land managers to land whales in a particular location. Mr. Schubert does not cite to a statutory or regulatory MMPA requirement that the proposed regulations govern where a whale may be landed.

33. Mr. Schubert notes that the proposed regulatory definition of "Makah Indian handicrafts" requires such handicrafts to be "significantly altered" from their natural form, but NMFS has not included a definition of "significantly altered" in the proposed regulations. Schubert Decl. ¶ 57. NMFS and the U.S. Fish and Wildlife Service impose similar restrictions in regulations governing native handicrafts (50 C.F.R. § 216.3(3) and 50 C.F.R. § 18(3), respectively), using but not defining the term "significantly altered." The proposed regulation is consistent with that established approach.

34. Paragraph 58 of Mr. Schubert's declaration argues that the proposed regulatory definition of "strike" or "struck" includes reference to "a harpoon or other device," but NMFS has not explained or defined what constitutes an "other device" and urges NMFS to clarify the term. Reference to the use of a "harpoon or other device" was intended to provide broad coverage as to the type of weapon the tribe may use to attach a float to a whale, for example, a darting gun. We consider the use of the broader term to be appropriate so as to cover any possible device that might be capable of penetrating a whale's skin but may consider further clarification in the regulations to address this concern.

35. Mr. Schubert raises questions about independent hunt observers, disclosure of data collected by independent hunt observers, and the process for resolving any potential discrepancies between information provided by the Makah observer and an independent observer. Schubert Decl. ¶ 59. The regulations do not require an independent observer to be present for each hunting expedition. Although it is likely NMFS would assign an observer to hunts during the early years of hunting, this may not be necessary after the Tribe and NMFS gain experience with a hunt. NMFS does not believe it necessary or appropriate that the regulations detail every nuance of hunt management (*e.g.*, how discrepancies would be resolved between observer data and tribal reporting), as such issues fall within standard operating procedures that are more appropriately addressed through adaptive management. In this regard, although the proposed waiver would cover a ten-year period, the Tribe would need to apply for permits whose duration would be limited to three to five years and would allow for modification as necessary based on the best information available. Proposed Regulations § 216.113(a)(1).

36. In paragraph 60 of his declaration, Mr. Schubert argues that NMFS has failed to explain why it is necessary to allow training approaches and training harpoon throws. He states that native whalers in Alaska do not engage in hunting approaches or training harpoon throws, so the Makah should not either. Schubert Decl. ¶ 60. In response, we consider hunt training to be an important component of the management of a tribal hunt, and as discussed in the 2015 DEIS (Section 3.4.3.5.6 Training and Weapons Improvement), hunt training is likely to reduce the time to death of struck whales and decrease the proportion of struck and lost whales. We also note that the Alaska Eskimo Whaling Commission (AEWC) has a weapons improvement program and has determined that "continued training on the proper use of the penthrite projectile is essential to the safety and success of the program and the ability of the AEWC to meet the

mandates placed on the aboriginal hunt by the International Whaling Commission." *See* *http://www.aewc-alaska.com/wip.html*. With respect to training, the proposed regulations are more restrictive than recommended by the Marine Mammal Commission, which urged more leniency on training approaches and harpoon throws. NMFS Ex. 1-11, at 2-3 (MMC 2017). The approach we take in the proposed regulation allows the tribe an overall number of approaches and harpoon throws, including both hunting and training. *See* Proposed Rule, 84 Fed. Reg. at 13,610-11; Proposed Regulations § 216.113(a)(4)(i)-(ii). It would be left to the Tribe how to allocate those limits between hunts and hunt training. The important effect, from NMFS's perspective, is that overall interactions between hunters and whales are kept within acceptable limits.

37. Paragraphs 61-65 of Mr. Schubert's declaration raise numerous questions related to the proposed regulatory definition of "strike," particularly with respect to multiple strikes on the same whale. Mr. Schubert argued that if his interpretation of the definition and strike limits were not consistent with NMFS's intent, then NMFS must publish a revised proposed rule in the Federal Register and provide a new opportunity for submission of direct testimony. Schubert Decl. ¶ 65. It was not NMFS's intention to count multiple strikes on the same whale separately against the strike limits, which is obvious from the manner in which we described and evaluated the likely effects of the hunt on gray whales. *See, e.g.*, Proposed Rule, 84 Fed. Reg. at 13,611. We intend to clarify this prior to issuing any final regulations, which we would consider to be a technical revision.

38. Mr. Schubert raises questions regarding the 24-hour waiting period between strikes during even-year hunts. He presumes that the waiting period is for the purpose of determining if a struck whale is a WNP whale and questions the feasibility of collecting data

(samples, photographs) that would allow such an identification. Schubert Decl. ¶ 67. Mr. Schubert misconstrues the intent of the cited provisions. The regulations include a requirement that tribal hunters wait 24 hours after striking a whale before they may strike another whale during even-year hunts. Proposed Rule, 84 Fed. Reg. at 13,608; Proposed Regulations § 216.113(a)(4)(iii). This is to prevent hunters from striking multiple WNP whales that could be traveling together. It is only once a whale is landed that hunters must wait for NMFS to confirm that it was not a WNP whale before they may hunt again. The methodology for making this determination is detailed in the photo-identification protocol. Yates Decl. Ex. 1-9 (NMFS 2019b). The proposed regulations do not attempt to impose quality control requirements on the collection of information regarding whales that are struck and lost. It may be difficult in a hunt situation to obtain photographs of sufficient quality for identifying whales. We also considered it could potentially interfere with safety of those on the water to impose more specific requirements. The main purpose of having an observer present is to ensure hunt protocols are followed, not to ensure that we can positively identify struck and lost whales. While it would be ideal to be able to positively identify every struck and lost whale, it is not practical given the constraints of a hunt on the ocean. Instead, the regulations take the approach of accounting for struck and lost whales according to their presence in the hunt area if positive identification through photo-identification or genetic matching is not possible. The presence of WNP whales within the Makah U&A is rare.

39. Paragraphs 71 and 72 of Mr. Schubert's declaration ask numerous questions related to enforcement of the proposed regulations. NOAA Office of Law Enforcement (OLE) agents, or Washington Department of Fish and Wildlife enforcement officers deputized to enforce federal laws and regulations through a Joint Enforcement Agreement with NOAA OLE,

would enforce provisions regarding the use of edible and inedible whale parts, as they do generally for possession of marine mammal parts. They would also enforce the section of the regulations regarding prohibited acts, as they do for other marine mammal regulations. We do not normally specify enforcement strategies in regulations.

40. Mr. Schubert questions the data quality standard regarding PCFG abundance numbers that NMFS would provide to the tribe. Schubert Decl. ¶ 73. The MMPA provides the standard for data quality, which is the best scientific evidence available. It is unnecessary for the regulations to repeat this standard for each type of information used in management.

41. The proposed regulations set a limit on the number of PCFG whales that may be struck (16 over 10 years), a method for identifying PCFG whales (matches to the photo catalog), a method of accounting for PCFG whales that may be struck in even-year hunts but cannot be identified (according to the proportion of PCFG whales), and a method of accounting for PCFG whales struck in odd-year hunts (all whales struck in odd-year hunts count as PCFG whales). Mr. Schubert questions why a similar approach is not taken for WNP whales. Schubert Decl. ¶ 74. The regulations do not authorize strikes on WNP whales and do not include provisions accounting for strikes of WNP whales. Rather, if a single WNP whale is struck, the hunt would be suspended until measures were taken to ensure no more WNP whales were struck. It would not be consistent with the best available scientific evidence to count unidentified struck whales in odd-year hunts as WNP whales, because there is no scientific evidence documenting the presence of WNP whales in the hunt area during the months when odd-year hunts would occur. It would also defy the best available scientific evidence to count an unidentified struck whale as a WNP whale in an even-year hunt, because the chance of hunters striking a WNP whale in an even-year hunt is only one and a half percent. *See* Second Moore Decl. ¶ 8. Finally, it would not

be productive to count unidentified struck whales during even-year hunts as WNP whales in proportion to their presence because a single unidentified struck whale would count as 0.005 of a whale, therefore 200 unidentified whales would need to be struck to add up to a single WNP whale.

42. In the proposed regulations, NMFS requires tribal hunt observers to determine whether a struck whale that is not landed "suffered a wound that might be fatal." 50 C.F.R. § 216.117(a)(1). Mr. Schubert questions what training a tribal hunt observer would need to be able to make such a determination. Schubert Decl. ¶ 75. The regulations limit the number of "strikes" and that term is described with specificity. NMFS considers a struck whale as killed for purposes of analysis in the DEIS and in the waiver proposal, however it is likely that not all struck whales will die. The reporting requirements for hunt observers include a judgement as to whether the wound is sufficiently severe to cause death. This is a matter of biological judgement. It would be unproductive and overly detailed to impose requirements on the training of hunt observers regarding this judgement. An alternative approach would be to simply have the hunt observer describe any wounds and the whale's condition following the strike.

43. The proposed regulations call for a panel of experts to review the humaneness of hunting methods following eight strikes. *See* Proposed Rule, 84 Fed. Reg. at 13,610; Proposed Regulations § 216.117(b)(2). Mr. Schubert argues that while such reviews are appropriate, they should be conducted annually to ensure that a hunt is using the least cruel killing methods available. Schubert Decl. ¶ 76. NMFS chose the trigger of eight strikes rather than calling for a review on a time schedule because it is unknown how many strikes, if any, might occur each year. We selected eight to represent a sufficient number from which a panel of experts would be able to draw general conclusions. Nothing in the regulations prevents NMFS from convening a

panel of experts for such a review before eight strikes have occurred if circumstances indicate it would be informative. In any event, NMFS must make a determination about the humaneness of a proposed hunt in conjunction with issuing a hunt permit.

44. Mr. Schubert misquotes Issue of Fact I.A.7 identified in NMFS's Notice of Hearing (84 Fed. Reg. 13,639, 13,641 (2019)), stating "The proposed waiver, at a maximum, would result in the deaths of 225 whales over 10 years, or an average of 2.5 per year." Schubert Decl. ¶ 80. The maximum number of gray whales that could be killed by Makah hunters over the 10 years of the regulations is 25, not 225. It is possible fewer whales than 25 would be killed because hunters may not make all 25 strikes that are authorized and not every strike may result in a death.

45. Referencing Issue of Fact I.A.21 identified in NMFS's Notice of Hearing (84 Fed. Reg. at 13,641), "[u]nder the proposed waiver, NMFS would manage impacts of the proposed waiver to PCFG whales through photo-identification and specified assumptions," Mr. Schubert urges NMFS to clarify what is meant by "specified assumptions." Schubert Decl. ¶ 88. The reference in the waiver proposal to "specified assumptions" means the assumptions specified in the regulations regarding accounting for unidentified struck whales. *See* Proposed Rule, 84 Fed. Reg. at 13,609; Proposed Regulations § 216.114(a)(2).

OTHER MATTERS

46. Ms. Owens's asserts in her declaration that NMFS must consult with the Olympic National Park (ONP) regarding the proposed waiver and regulations. Owens Decl. ¶ 20. There is no statutory requirement for NMFS to consult with the ONP. The ONP did not comment on either the 2008 or 2015 DEISs. Ms. Owens's declaration appears to be primarily concerned with park visitor safety, which would be taken into account through the hunt permitting process if

NMFS ultimately makes a decision to issue a waiver and regulations. *See* Proposed Rule, 84 Fed. Reg. at 13,608; Proposed Regulations §§ 216.113(a)(5), (6)(v).

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.

Chris E Yates

Chris Yates

Dated: August 5, 2019

NOAA Office of General Counsel NW
7600 Sand Point Way NE
Seattle, WA 98115

THIRD DECLARATION OF CHRIS YATES
EXHIBIT LIST

1-19	Nerini 1984	Nerini, M. 1984. A review of gray whale feeding ecology. Pages 423-450 in Jones, M. L., S. L. Swartz, and S. Leatherwood, editors. The Gray Whale Eschrichtius robustus. Academic Press, Inc., Orlando, FL.
1-20	NMFS 2019e	NMFS. 2019e. Map of ENP gray whale distribution, including the PCFG range and the proposed hunt area. Map created August 1, 2019 by S. Stone, NMFS.

The Gray Whale
Eschrichtius robustus

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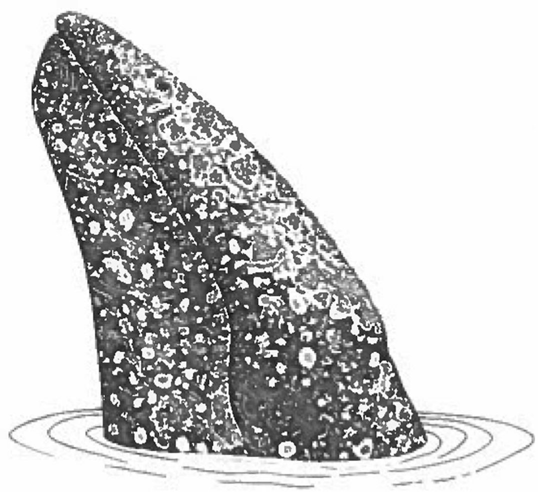

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18

A Review of Gray Whale Feeding Ecology

Mary Nerini

Introduction and Methods

The gray whale (*Eschrichtius robustus*) is unique among large cetaceans in that it feeds primarily upon benthic organisms. In so doing, it leaves a record in the sediments, however obscure, of where it has been and what it has eaten. Because it is difficult to observe feeding whales directly, and because of the paucity of stomach content data, such records offer valuable clues to the interactions between the gray whale and the benthic community.

This chapter reviews information available on such questions as How do gray whales feed, where do they feed, what do they eat, how much do they eat, and how do they influence their prey community? As a review, it is based largely on published information. It also, however, incorporates unpublished observations of feeding gray whales recorded by many researchers along the west coast of North America and results of my own research in the Bering Sea in June–July and September 1980.

My research was conducted aboard the NOAA ship *Surveyor* operating primarily in the Chirikov Basin of the northern Bering Sea. It was designed to study both feeding of gray whales and dynamics of the benthic amphipod communities on which they were known to feed. Methods and findings were presented in detail in Nerini *et al.* (1980) and are only summarized here.

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A cruise June 23 through July 17 operated off Southeast Cape, St. Lawrence Island, in the band between about 168 and 169°W from the northeast tip of the island to about 65°N. A cruise September 10–30 operated exclusively off Southeast Cape. During the June–July cruise, we towed a Klein and Associates Side–Scan Sonar unit with a 500-kHz transducer.[1] The sonar, recording a strip of ocean floor 50 m wide, proved capable of detecting bottom features such as depressions or mounds in the surface of the sediments. Over the approximately 787 km it was towed, the sonar's traces provided insight into sizes and shapes of feeding depressions made by whales.

During both cruises we used a 0.1-m^2 Smith-MacIntyre Grab, a 0.025-m^2 box corer, and scuba divers to collect bottom samples. Each diver-collected sample contained 0.0188 m^2 of material. The grab samples were sieved through a 1-mm mesh; the diver collected cores through a 0.5-mm mesh. Materials remaining on the screens were fixed in 5% formalin and transferred to 70% ethanol.

Feeding Mechanism

Although other whales may occasionally sample the bottom fauna, the gray whale is the only baleen whale known to regularly consume benthic resources (Nemoto, 1970). Numerous authors, beginning with Scammon (1874), have noted gray whales surfacing with bottom sediments clinging to the rostrum and spewing from the mouth. The baleen is sturdy and adapted to contact with bottom sediments; the plates are thicker and the hairs are coarser and less numerous than those of any other mysticete (Nemoto, 1959).

The mechanism by which the whales collect the benthic organisms is still unclear although several hypotheses have been advanced. Walker (1971) made the unlikely suggestion that the whales acted as bulldozers, engulfing "power-shovel helpings" of benthic fauna and the associated sediments. As the prey organisms of gray whales live in the upper 2 cm of the sediments, a deep scoop would be unnecessary. Furthermore, cetacean skin is easily abraded and would not withstand extensive plowing through sandy sediments. From the available data it seems more probable that gray whales somehow suck in their prey and at least partially separate them from the sediments. Kasuya and Rice (1970) document greater wear of the baleen on the right side of most gray whales coinciding with fewer barnacles and more skin abrasions of the head region. From this evidence they inferred that most whales feed while on their right sides taking in some sediment with their prey items and occasionally coming in contact with the bottom.

Gigi II, a captive juvenile gray whale, provided an opportunity to make detailed observation of feeding. Although one could argue that Gigi's behavior in a small cement enclosure may not have been identical to the natural behavior of gray whales, it is probably instructive; I recount the salient details presented in Ray and Schevill (1974). Approaching squid strewn on the floor of her pool, Gigi first rolled 120° onto her left side

[1]The use of trade names in this report is intended as documentation and does not imply endorsement of products by the author or the National Marine Fisheries Service.

so that her mouth was parallel to the bottom and 10–20 cm above it. As she traveled over the squid, she apparently created a pulsating suction with her mouth (probably by depressing her muscular tongue) leaving a clear swath of 30–50 cm in the food. Her direction of travel while on her side was dorsad of straight ahead. In other words, she swept across the squid at an angle 30° to her mouth. A similar behavior was documented in the waters off southern California by two scuba divers (Grigg and Dana, 1969), although they attributed the roll to a fright response. More recently, Hudnall (1981) filmed a feeding whale in the Straits of Juan de Fuca. This whale is reported to have rolled onto its side, swept very near the bottom, righted itself, and disappeared behind a cloud of sediment. In its wake the whale left depressions in the bottom sediments that although unmeasured were estimated to be approximately the size of its head.

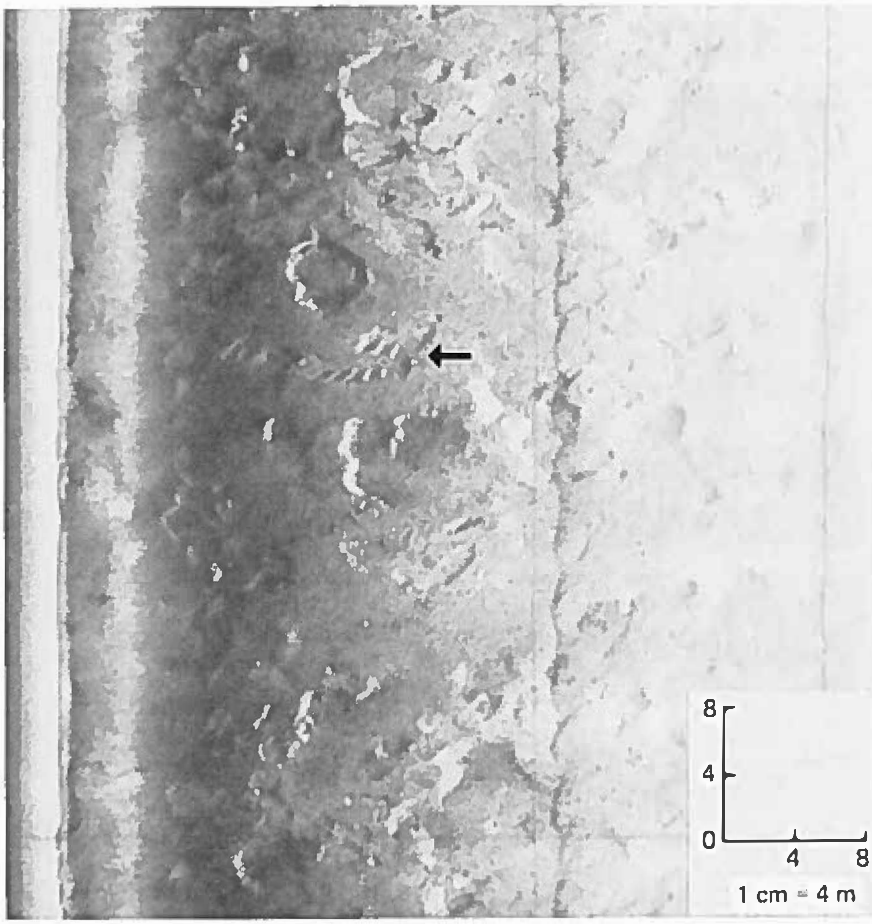

Fig. 1. *Side-scan sonar record of the Bering Sea floor made during July 1980. The patterns at the arrow are probably depressions produced by a feeding gray whale.*

We had hypothesized that whales feeding near the bottom would leave a record of their activities, albeit a complex record, in the sediments, from which we might infer aspects of their feeding ecology. This has proved to be the case: The side-scan sonar was able to distinguish bottom features that may have been produced by foraging gray whales in the Bering Sea (Fig. 1).

These bottom features were unique to the Chirikov Basin and the nearshore regions

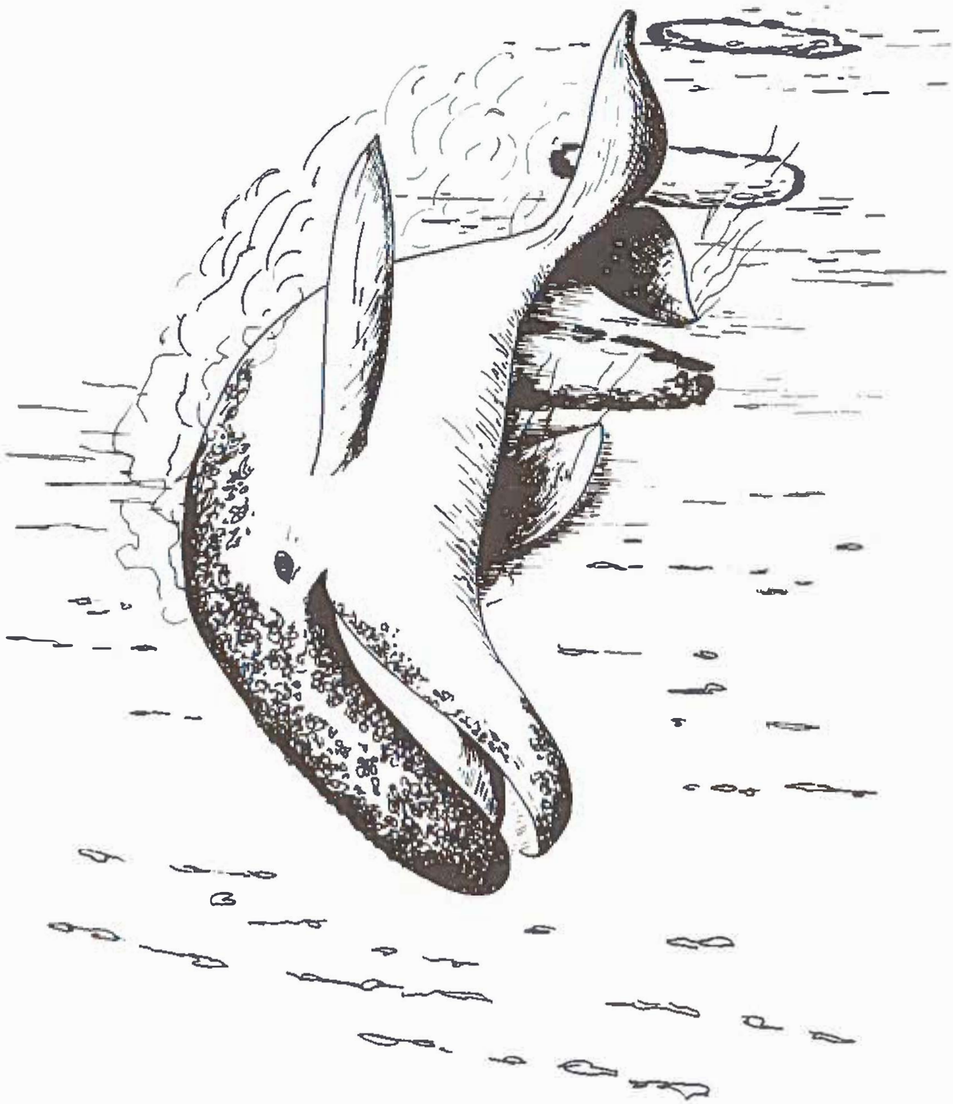

Fig. 2. *Schematic figure of feeding gray whale and resultant bottom depressions. Although depicted as open in this figure, the left side of the whale's mouth is probably closed while feeding.*

of St. Lawrence Island as seen on our cruise. Their occurrence and orientation were irregular, suggesting the features were biogenic in origin. Furthermore, these features were only seen when feeding gray whales were in the immediate area and their shape and size were consistent with the previously described feeding mechanism. That is, a whale moving while on its side and sucking up infauna in pulses should theoretically leave a series of oblong, mouth-sized depressions from which only the top layers of sediment were removed (Fig. 2). The only other large benthic predator (excluding the bowhead whale) capable of creating such a massive disturbance is the walrus (*Odobenus rosmarus*). Walrus however feed differently than gray whales, leaving long, narrow sinuous tracks or small pits (Oliver *et al.*, 1983) which we were able to differentiate on the side-scan sonar (Fig. 3).

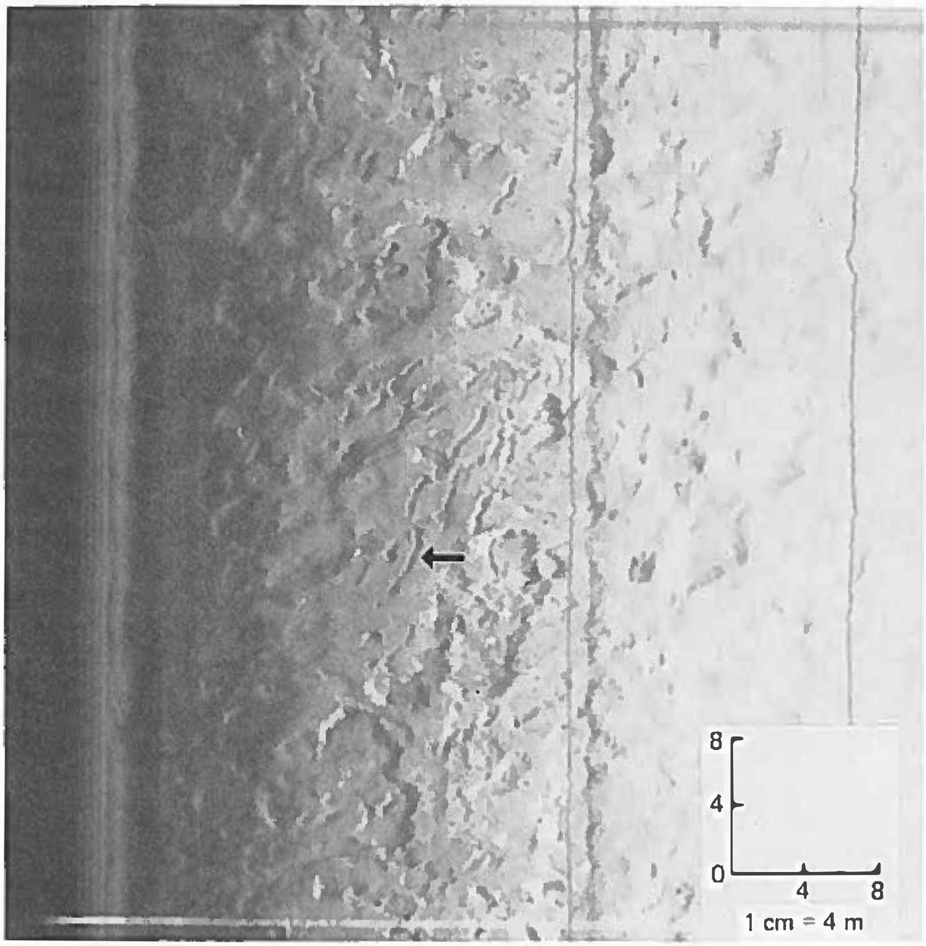

Fig. 3. *Side-scan sonar record of the Bering Sea floor collected during July 1980 with a 500-kHz transducer. The arrow indicates furrows probably produced by a feeding walrus.*

Each bottom trace is composed of a series of small depressions often arrayed in a slight curve (Fig. 4), where the entire series of depressions probably represents the feeding by one whale in one dive. The mean size of the component depressions measured from the side-scan records was 1.6 × 0.6 m (n = 13). The entire feature was composed of (a mean of) 6.4 such depressions (n = 15) and ranged in total length from 2.1 to 6.9 m (n = 13). The maximum abundance of the features was 9/km. Because these features were relatively small and because the edges of the depression were recorded indistinctly these measurements have an accuracy of approximately 0.3 m.

Recently, more extensive side-scan information has been analyzed from the northern Bering Sea. From this data it appears that the bottom features produced by recently foraging whales can be distinguished from older, current-scoured feeding depressions on the basis of size and shape. In this fashion fresh feeding depressions were defined as those ranging from 1 to 3 m long and from 0.5 to 1.5 m wide (Nelson *et al.*, 1983). Depressions measured *in situ* by scuba divers were elliptical with mean dimensions of 1.1 m (n = 14, SE + 0.50) × 1.65 m (n = 14, SE = 0.77).

In addition to its bottom-feeding abilities, the gray whale is also capable of feeding on pelagic prey by surface skimming and engulfing. Hubbs (as reported in Pike, 1962) reported gray whales circling tightly, apparently feeding on spawning squid; J. Sumich (personal communication) and S. Leatherwood (personal communication, 1982) have seen similar circling of bait fish. Gilmore (1961) observed gray whales "criss-crossing" through a dense school of small fish, and Sund (1975) reported two occasions of a group of whales forming a tight circle around a school of small fish; each whale in turn would dive and surface through the fish school with its mouth open in a fashion similar to the balaenopterid whales.

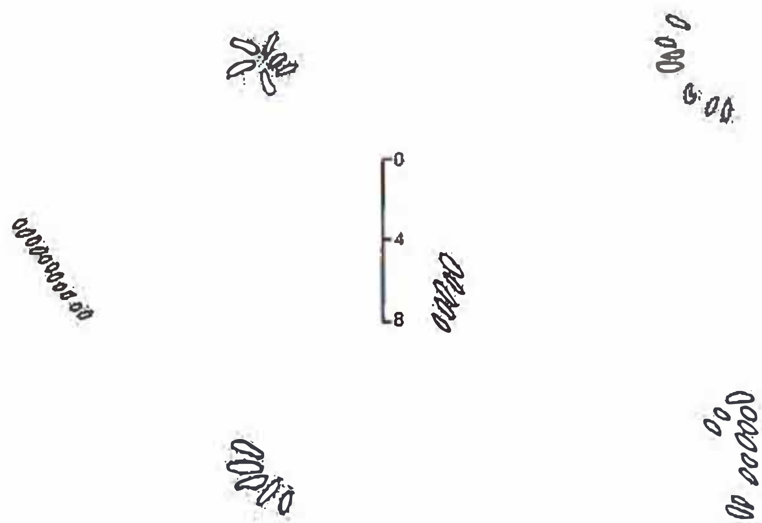

Fig. 4. *Shapes of six bottom features produced by feeding gray whales and detected by the side-scan sonar.*

Norris *et al.* (1983) offered evidence that gray whales feed in the Baja lagoons by orienting themselves against a tidal current or rip and allowing the water to funnel planktonic food items to them. R. Gill (personal communication, 1982) reports similar behavior from Nelson Lagoon, Alaska. Murison *et al.* (Chapter 19, this volume) documented whales feeding in an inverted position off Vancouver Island on mysiid swarms located approximately 1 m above a rocky bottom. Hudnall (1981), also off Vancouver Island, filmed a foraging whale engulfing a swarm of mysids hemmed in by a rock face. Wellington and Anderson (1978) reported on a use of surface skimming in the center of a dense kelp bed, and Swartz and Jones (1981) reported similar skimming of windrows of eel grass (*Zostera marina*) in one of the breeding lagoons.

Thus, with three modes of feeding, benthic suction, engulfing, and skimming, the gray whale has perhaps a greater range of foraging techniques than any of the other great whales (cf. Nemoto, 1970). This diversity may lend the gray whale greater dietary flexibility, lessening its reliance on any single prey item, and consequently providing it with greater resilience with regard to changes in its food resources.

Evidence of Feeding

The best and the only irrefutable proof that a whale is feeding is derived from its stomach contents, but there are other less drastic ways of identifying feeding whales. As mentioned earlier, the whale takes in some sediment as it feeds on the bottom; this sediment, finer than the associated prey items, is expelled through the baleen as the whale surfaces, producing a sediment trail. These mud plumes are clearly visible from an aircraft (Fig. 5), the elevated shoreline, or a nearby vessel. Most reports of feeding whales are so categorized because of the presence of mud plumes; however, the presence of mud plumes is not unequivocal evidence of feeding activity. Plumes of sediment could be created by whales investigating a prey community or contacting the bottom for some other reason, and thus activities can be erroneously reported as feeding. Sightings of defecating whales, fecal slicks, reports of whales with foul-smelling breath, or of whales trailed by seabirds are other indicators of feeding that are less frequently noted. Some investigators have identified feeding whales by extended observations of an animal "working" an area (i.e., systematically and repeatedly diving in a small locality). Other cues include the presence of bottom disturbances produced by foraging whales, either observed directly using scuba or indirectly using a closed-circuit video system or a side-scan sonar.

Feeding Areas

Gray whale feeding behavior can be categorized by three areas: in and near the Baja lagoons, along the migratory corridor, and in the nothern Bering, Chukchi, and (rarely) Beaufort Seas. Available accounts, summarized in Table I are discussed next.

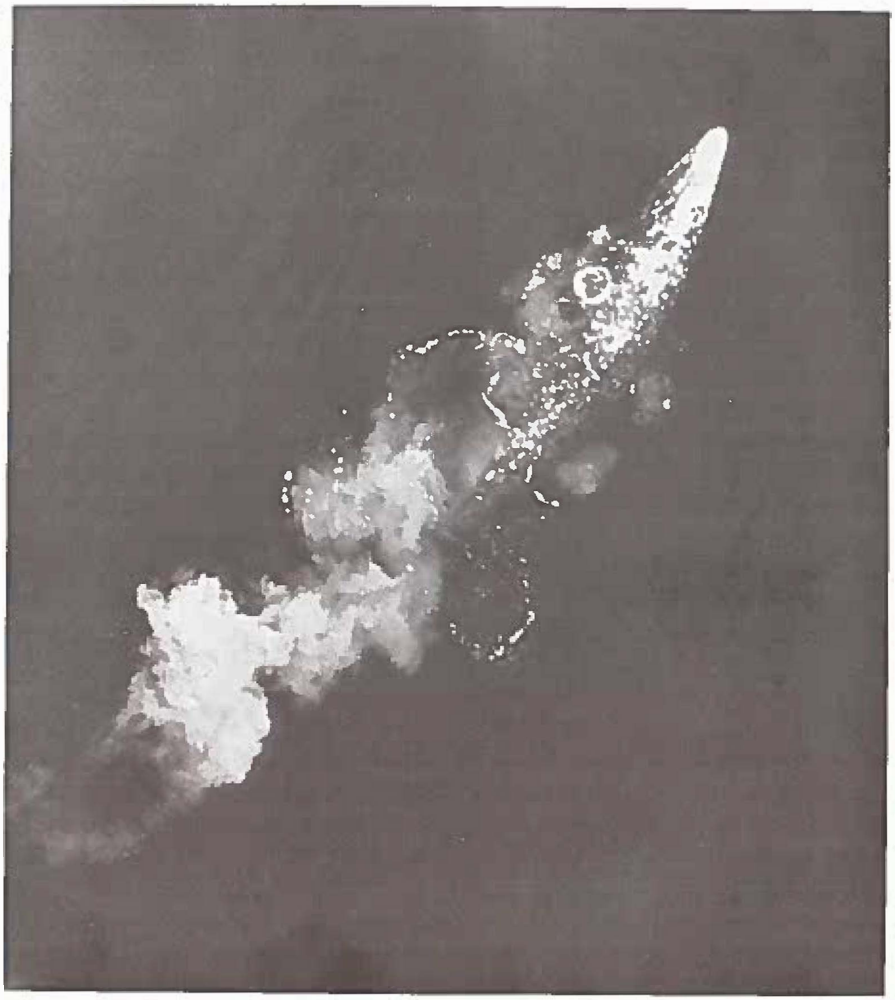

Fig. 5. *Aerial photograph of a feeding gray whale illustrating the "mud plume." Photograph taken on June, 1976 in the Bering Sea, by H. Braham.*

THE BAJA LAGOONS

There are very few reports of feeding whales from the breeding lagoons. Walker (1949) reported finding sardines in a stranded gray whale found in Laguna Ojo de Liebre (LOL). Norris *et al.* (in press) reported feeding on *Pleuroncodes* spp. and *Nyctiphanes* spp. at the mouth of Bahia Magdalena, and J. Sumich (personal communication) twice saw gray whales in Laguna San Ignacio (LSI) criss-crossing through schools of bait fish. Hubbs (as reported in Pike, 1962) learned from fisherman in the area that the stomach of a gray whale stranded in LSI was filled with "sardines," a collective term that he thought

Table I
Locations Known to be Frequented by Foraging Gray Whales Exclusive of the Northern Bering and Chukchi Seas

Location	Probable prey item	Feeding and other behavior	Bottom substrate	Reference
San Ignacio Lagoon, Baja California, Mexico	Eelgrass mats, Associated small crustaceans	Surface skimming	Sand	Swartz and Jones (1980)
San Ignacio Lagoon, Baja California, Mexico	Unidentified bait fish	Tight circling and engulfing	Sand	J. Sumich[a] (personal communication)
Magdalena Bay, Baja California, Mexico	*Pleuroncodes* (pelagic red crab), *Nyctiphanes*	Regular dives, attending seabirds, tidal feeding	—	Matthews (1932), Norris *et al.* (1983)
Punta San Juanico, Baja California	Unknown	Sediment trails	Unknown	D. Rice[b] (personal communication)
Laguna de San Quentin, Baja California, Mexico	*Ampelisca*	Unknown	Sand	Sprague *et al.* (1978); Mate and Harvey (Chapter 25, this volume)
La Jolla, California	Spawning squid	Unknown	Unknown	Pike (1962)
Point Loma, California	Unknown	Mouthing kelp	Kelp bed	S. Leatherwood[c] (personal communication)
Point Mugu, California	Unidentified bait fish	Circling and swimming erratically through schools	Sand	S. Leatherwood[c] (personal communication)
Santa Barbara, California	*Acanthomysis*	Surface feeding	Kelp bed	Wellington and Anderson (1978)
San Miguel Island, California	Unknown, possibly small pelagic red crustaceans	Mouthing kelp at surface	Kelp bed	G. Antonelis[d] (personal communication)
Port San Louis Harbor, California	Unknown	Churning bottom	Sand, kelp bed	A. Roust[e] (personal communication)
Piedras Blancas, California	Unknown	Sediment trails, mouthing kelp	Sand, kelp bed	M. Poole[f] (unpublished manuscript)
Monterey, California	Unidentified bait fish	Circling and engulfing	Unknown	Sund (1975)

(continued)

Table I (*Continued*)

Location	Probable prey item	Feeding and other behavior	Bottom substrate	Reference
Moss Landing, California	*Diapatra*	SCUBA observations	Sandy mud	C. Goebel[g] (personal communication)
Farralon Island, California	Unknown	Sediment trails	Unknown	D. Ainley[h] (personal communication)
Point Reyes, California	Unidentified amphipods	Sediment trails	Unknown	B. Jones[i]
Russian River, California	Unknown	Side-scan sonar depressions	Sand	G. Tate[j] (personal communication)
Eureka, California	Unknown	Sediment trails	Unknown	J. Heyning (personal communication)
Crescent City, California	*Euphausia*	Unknown	Rocky shore	Howell and Huey (1930)
Klamath River, California	Unknown	Unknown	Unknown	T. Dohl[k] (abstract)
Port Orford, Oregon	Unknown	Moving back and forth near breakwater	Unknown	T. Loughlin[l] (personal communication)
Cape Falcon, Oregon	Unknown	Sediment trails	Unknown	S. Jeffries[m]
Sea Lion Rock, Oregon	Unknown	Moving back and forth	Unknown	T. Loughlin[l] (personal communication)
Grays Harbor, Washington	Unknown	Shallow dives, flukes out	Unknown	S. Jeffries[m] (personal communication)
La Push, Washington	Unknown	Diving in same spot, no sediment trails	Sand	M. Dahlheim[n] (personal communication)
Neah Bay, Washington	Unknown	Shallow dives on side, milling in kelp bed; no sediment trails	Rocky, kelp bed	G. Joyce[o]
Tapaltos Bay, Vancouver Island, British Columbia	*Holmesimysis*	Inverted position, fecal material, no sediment trails	Kelp bed, rocky shore	Murison *et al.* (Chapter 19, this volume)
Wickaninish Bay, and along the west coast of Vancouver Island, British Columbia	*Onuphis*	Diving in the same spot, sediment trails	Sand	Darling (1977)
Pachaena Bay, British Columbia	*Ampelisca* spp.	Feeding excavations	Sand	Oliver *et al.* (in press)

Table I (*Continued*)

Location	Probable prey item	Feeding and other behavior	Bottom substrate	Reference
Pachina Point, Vancouver Island, British Columbia	Unknown	Diving in same spot, no sediment trails	Unknown	Hart (1977)
Rose Spit, Queen Charlotte Island	Unknown	Sediment trails	Unknown	Hatler and Darling (1974)
Chichagof Island, Alaska	Shrimp-like organisms	Near surface, passes, attending seabirds	Rocky, kelp bed	C. Johnstone[f] (personal communication)
Cape St. Elias, Alaska	Unknown	Surface swimming and gulping	Rocky point	Cunningham and Stanford[g] (unpublished manuscript)
Nelson Lagoon, Alaska	*Crangon*	Tidal feeding, no sediment trails	Sand, rock	R. Gill[r] (personal communication)
Port Heiden to Port Moller, Alaska	Unknown	Mud trails very near surf zone	Unknown	Braham *et al.* (1977)
Ugashik, Alaska	*Anonyx*	Rolling about near surface	Sand	K. Hallinger[s] (personal communication)
Pack ice edge, N. Central Bristol Bay	Unknown	Mud trails	Unknown	S. Leatherwood[c] (personal communication)
Goodnews Bay, Alaska	Herring	Unknown	Unknown	Frost *et al.* (1982)
St. George Island, Alaska	Unidentified amphipods	Mud trails, foul breath	Sand	R. Gentry[t]
St. Matthews Island, Alaska	Unknown	Shallow dives, nearshore	Sand	A. Sowls[u] (personal communication); G. Joyce[n] (personal communication)
South of St. Lawrence Island, Alaska	Unknown	Sediment trails	Unknown	E. Biggs (personal communication)

[a]J. Sumich, Grossmont College, El Cajon, California.
[b]D. Rice, National Marine Mammal Laboratory, Seattle, Washington.
[c]S. Leatherwood, Hubbs Sea World Research Institute, San Diego, California.
[d]G. Antonelis, National Marine Mammal Laboratory, Seattle, Washington.
[e]A. Roust, California Polytechnical State Univ., San Luis Obispo, California.
[f]M. Poole, Biology Dept., Sonoma State Univ., Rohnert Park, California.
[g]C. Goebel, Univ. of Washington, College of Fisheries, Seattle, Washington.
[h]D. Ainley, Pt. Reyes Bird Observatory, Stinson Beach, California.
[i]B. Jones, Museum of Vertebrate Zoology, Berkeley, California.
[j]G. Tate, U.S. Geological Survey, Menlo Park, California.
[k]T. Dohl, p. 25 in *Abstr. of Fourth Conf. on Biology of Marine Mammals, 1981.*

(*continued*)

Table I (*Continued*)

[l]T. Loughlin, National Marine Mammal Laboratory, Seattle, Washington.
[m]S. Jeffries, Washington State Dept. of Game, Astoria, Oregon.
[n]M. Dahlheim, Univ. of British Columbia, Vancouver, B.C.
[o]G. Joyce, National Marine Mammal Laboratory, Seattle, Washington.
[p]C. Johnstone, Sitka, Alaska.
[q]W. Cunningham and S. Stanford, Alaska Dept. Fish and Game, Anchorage, Alaska.
[r]R. Gill, Fish and Wildlife Service, Anchorage, Alaska.
[s]K. Haflinger, Univ. of Alaska, Institute of Marine Science, Fairbanks, Alaska.
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[u]A. Sowls, Fish and Wildlife Service, Anchorage, Alaska.

the fisherman used for any small bait fish. Swartz and Jones (1980, 1981) sighted whales with mud plumes in LSI; however, they did not feel this was indicative of feeding because when they sampled the bottom fauna they found a depauparate benthic fauna.

The pelagic realm appears to be richer. From various plankton tows taken in LSI, copepods and mysids appeared abundant in the vicinity of eel grass mats (Swartz and Jones, 1980, 1981). Crab larvae (150/m^3) and euphausiid juveniles (182/m^3) were also reported in dense concentrations at the mouth of Bahia Magdalena (Norris *et al.*, in press). Thus, the benthic resources available to the gray whale appear to be minimal in the lagoons, a hypothesis that is consistent with data on stomach contents. The feeding that does occur is probably on pelagic food items.

THE MIGRATORY CORRIDOR

The coastal migratory corridor from Baja California to the Bering Sea is approximately 6000 km long. Most whales appear to terminate the northward migration in the Bering Sea, presumably drawn by the rich benthic communities of the continental shelf. In evidence of this, Rugh (Chapter 10, this volume) estimated that 17,648 whales moved south through Unimak Pass and out of the Bering Sea in the fall of 1979, while Reilly (1981) projected a total population size of 17,557 animals from his 1979 count of whales passing Yankee Point, California.

Some whales do appear to linger along the Pacific coast to feed, rather than participate in the complete migration. In recent years there has been an increase in the number of records of gray whales summering south of the Bering Sea; off California (Dohl *et al.*, 1981); off Oregon (Chapters 12 and 13, this volume; Sumich, 1982); and off Washington and British Columbia (Chapter 12, this volume). An estimated 100 whales summer off these three last-named areas. Those summering off British Columbia, at least are principally engaged in feeding (Chapters 12 and 19, this volume; Oliver *et al.*, in press).

Whales destined to summer in northern waters also feed on both benthic and pelagic prey at select locations along the migratory route. Migrating whales have been seen feeding on bottom fauna mostly at the mouths of rivers or estuaries. For example, J. L. Sumich (personal communication) estimated that over 50% of the sightings of feeding whales (identified by mud plumes), made during aerial surveys of the Oregon coast were at river mouths. Similarly, S. Jeffries (personal communication, 1982) noted most feeding whales in the vicinity of rivers along the Washington coast. (However, most sightings of whales are near river mouths so the sighting effort confounds the data.) G. Tate (personal communication, 1982) also noted bottom features on the side-scan sonar near river mouths on the California coast that appear similar to those made by foraging whales in the Bering Sea. Sediments near river mouths may be organically enriched by comparison with the adjacent substrate, and consequently the benthic community may be richer.

Along the north side of the Alaska Peninsula, northward-migrating whales are commonly seen trailing mud plumes. Between Port Moller and Cape Greig, many seem to travel and feed in the area just seaward of the surf zone (personal observation). The sediments in this region are composed of coarse sand and gravel (Sharma, 1979) and the nearshore and littoral zones are often scoured by shorefast ice. Because of this ice scour and the course sediments, the prey items are possibly highly motile organisms, such as the scavenging amphipods and isopods. Whales found feeding in the vicinity of Ugashik, Alaska during early June, 1982, were believed to be preying on motile amphipods such as *Anonyx*. Large numbers of *Anonyx* sp., clinging to hydrozoans, were dragged up by fishing nets in the shallow areas where the whales were foraging and fishermen were working (K. Haflinger, personal communication).

The areas where whales are not seen feeding along their route are also of interest. For example, there was only one sighting of a feeding whale during 11 years of census operations conducted at Point Loma and Yankee Point, California (D. Rice, personal communication, 1982), and no sightings at Yaquina Head, Oregon during 2 years (Chapter 13, this volume). Similarly, very little feeding activity has been noted in the Unimak Pass area (D. Rugh, personal communication, 1982; Hessing, 1981) despite extensive observational effort during the migration. All of these observations were made from high bluffs with sharp escarpments and rocky bases. Possibly such headlands, ordinarily high-wave-energy regions, do not support appropriate benthic resources.

Sightings of whales feeding in the water column have been made along the entire range but are concentrated in the southern regions (Table I). They can be divided into those whales (juveniles?) feeding in kelp beds and those exploiting pelagic resources such as small schooling fish or crab larvae. The latter prey items are unpredictable in space, and consequently their exploitation by whales is probably opportunistic and certainly rare. S. Leatherwood (personal communication), who estimates having observed several hundreds of gray whales off California and northern Baja California by air and from vessels in 14 years, has recorded only one reliable feeding incident. In short, whales feeding while migrating or summering along the northern half of the migration route are nearly always consuming benthic resources.

THE NORTHERN SEAS

The northern feeding grounds of the Bering and Chukchi Seas are found on the expansive continental shelf. The region is shallow, generally less than 50 m deep in the northern Bering Sea and less than 68 m in the southern Chukchi Sea. The distribution of feeding whales in these waters has been reported by Braham (Chapter 11, this volume) and Moore and Ljungblad (Chapter 23, this volume). The gray whale distribution plot from Braham (Chapter 11, this volume) is reproduced in Fig. 6. In the Chirikov basin of the northern Bering Sea, this distribution coincides with that of an extensive infaunal

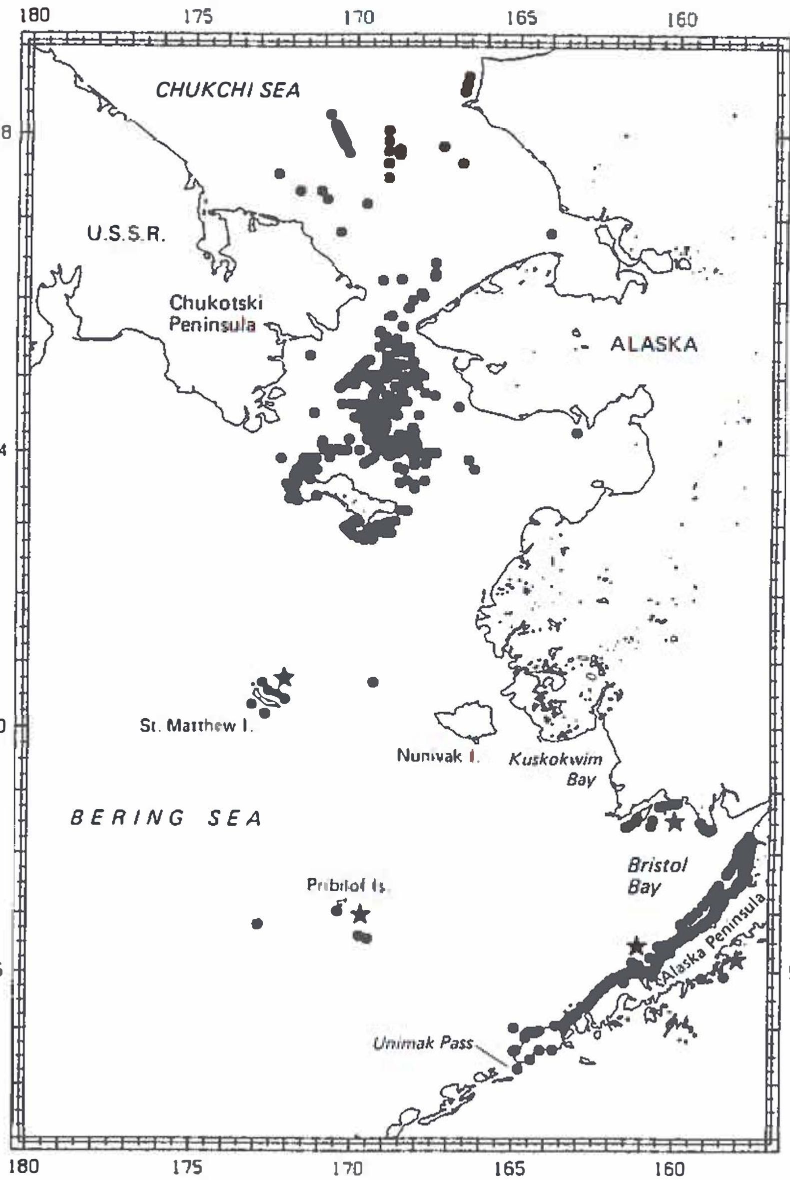

Fig. 6. *Distribution of feeding gray whales in the northern Bering Sea (Fig. 5 in Chapter 11, this volume).*

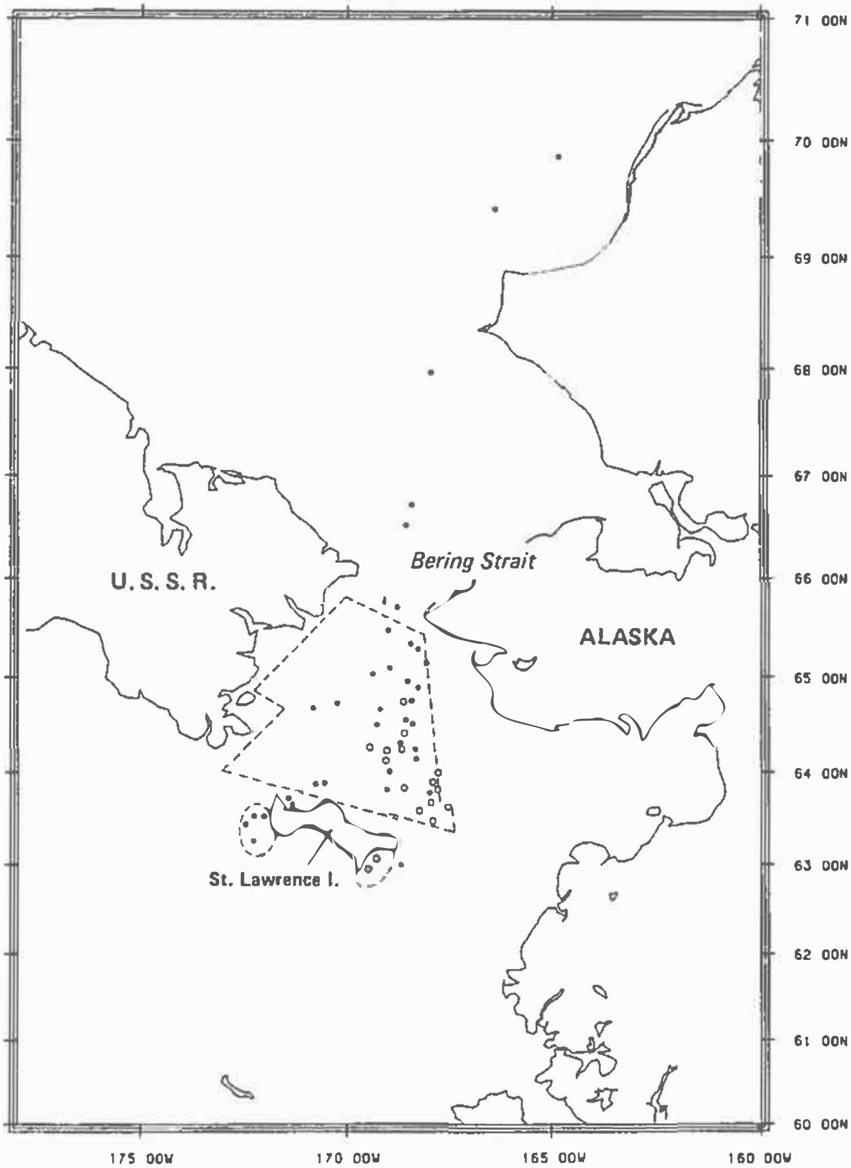

Fig. 7. *Distribution of the amphipod community in the Northern Bering Sea. Dotted line encloses the 3.7 × 10⁴ km² area estimated to be of greatest importance. Black circles (●), dominated by amphipods [in benthic samples collected by Stoker (1978)]; open circles (○), dominated by amphipods (in benthic samples collected by Nerini in 1980).*

amphipod community (Fig. 7), which is dominated by the ampeliscid amphipods, most notably *Ampelisca macrocephala*. Densities of ampeliscids alone in grab samples taken in this area during the 1980 research cruises ranged from 400 to 23,780 individuals/m^2. The mean combined amphipod biomass for this community was 161.5/m^2 (n = 133, SE = 142.4), and the maximum combined amphipod biomass in any single grab was 941/m^2. Stoker (1978) gave a mean total biomass for this region of 482 ± 286/m^2 wet weight in which *A. macrocephala* alone supplies 31% of the organic carbon biomass (calculated by author as 7.2 g/m^2). Earlier biomass estimates from this region ranged from 200 to 1000 g/m^2 (Kuznetsov, 1964).

The variance in amphipod densities and concomitant biomass is high throughout the region (C. V. ≈ 30%) and is partly related to the effect of the bottom depressions. That is, samples collected by scuba divers from within bottom depressions had lower densities of *Ampelisca* spp. than those taken outside the depressions ($p < .01$, Wilcoxon–Mann–Whitney rank–sum test, $n = 18$). The mobile scavengers were, however, in greater abundance inside of recently formed depressions. Furthermore, experimentally defaunated patches of the benthos created to simulate whale feeding pits showed a rapid recruitment to the denuded areas by the mobile scavengers (Nerini and Oliver, 1983). This has led to the belief that the gray whale foraging disturbance is instrumental in the structuring of the benthic community.

Other northern areas where whales have been noted feeding on the benthos include the nearshore waters of the western Bering Sea (Votrogov and Bogoslovskaya, 1980; Blokhin and Pavlyuchkov, in press), the southern capes of St. Lawrence Island (F. H. Fay, personal communication, 1977), the southern Chukchi Sea (Wilke and Fiscus, 1961), and the north side of the Chukchi Peninsula (Fedoseev, 1966; Miller *et al.*, 1984; Nasu, 1960). Benthic communities in these areas, clearly of importance to the whales, have not been well studied. The benthic community in the nearshore waters of the western Bering Sea is an amphipod assemblage (Kuznetsov, 1964), but the dominant amphipods are unknown. The southeastern cape of St. Lawrence Island has an amphipod assemblage dominated by *Ampelisca* in some localities and by *Photis* in others (personal observation). The area off the southwest side of St. Lawrence Island is apparently similar (Thompson and Martin, 1983). The subtidal area of St. Lawrence Island where we noted whales feeding in the surf zone supports a dense, probably seasonal community of isopods (*Gnorimosphaeroma* and *Synidotea* spp.) and scavenging amphipods (*Anonyx* and *Atylus* spp.) (Fig. 8). The southern Chukchi Sea had the highest biomass (1195 g/m^2) and levels of organic carbon (56.5 g/m^2) found on the Bering/Chukchi shelf (Stoker, 1978). Along the north side of the Chukchi Peninsula, the bottom community is variable; in areas where whales were found feeding, however, the dominant organisms were amphipod species of *Photis*, *Ampelisca*, *Pontoporeia*, and *Ischyrocerus*, and a cumacean, *Diastylis* sp. (Coyle, 1981).

The benthic foraging areas utilized by the whales seem to have one characteristic in common; they are underlain by dense crustacean infaunal communities. On the northern grounds, the predominant community form is an amphipod assemblage. Previous authors have expounded upon the importance of a particular amphipod, *Ampelisca*

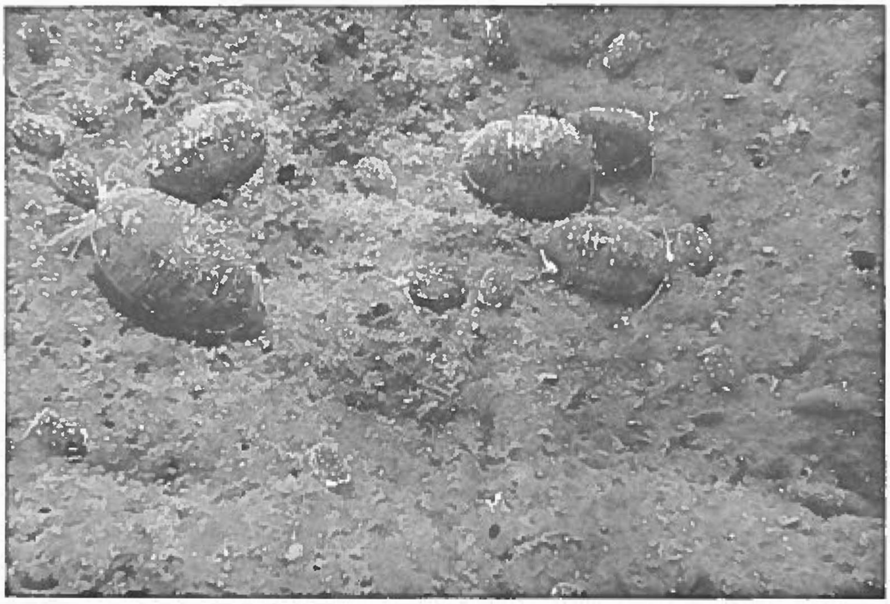

Fig. 8. *Epifaunal benthic community in the nearshore area (<10 m deep) of St. Lawrence Island. Isopods are genus* Synidotea. *Photo taken by L. Consiglieri. July 1980.*

macrocephala, to the diet of the gray whale. Because the whales feed in several different amphipod communities, I expect that the importance of this single species may be exaggerated; however, the complex of amphipods inhabiting the Chirikov Basin is certainly critical to the well-being of the population.

Stomach Contents and Prey Items

Stomach content data, although sparse, does exist from various regions of the gray whale's range. Although available data do suggest a general pattern of feeding in northern waters and fasting in southern waters (Rice and Wolman, 1971), the overall picture is more complex and has long been a subject of dispute. Whales taken in the Bering and Chukchi Seas usually have full stomachs. Zimushko and Lenskaya (1970) reported food in the stomachs of 85% of the whales taken in the Soviet whale fishery in the Bering and Chukchi Seas, whereas whales landed during migration on either side of the Pacific have rarely displayed evidence of recent of extensive feeding (Andrews, 1914; Mizue, 1951; Rice and Wolman, 1971); stomachs of whales taken from the winter grounds in the lagoons of Baja California have similarly been devoid of substantial food (Scammon, 1874). Although data on stomach contents are available from migrating whales which stranded along the west coast of the United States, one cannot assume these stomach contents are representative of the feeding by normal healthy animals. Further, stomach contents of stranded animals are usually severely decomposed rendering some prey items difficult to identify.

The list of prey items is extensive for gray whales (Table II), reflecting both their opportunistic approach to feeding and the nonselective nature of their feeding mechanism. Both pelagic and benthic fauna are consumed, although these two feeding modes are probably important in different areas of the gray whale's distribution. Prey inferred from the mode and area where whales were feeding are listed in Table I.

On the northern feeding grounds, benthic amphipods are clearly of paramount importance, with one or two species often comprising 90% of the food remains and many other species occurring in small quantities. Stomachs from 324 gray whales taken by Soviet whalers in the northern Bering Sea contained six dominant amphipod genera representing four families: the Ampeliscidae (*Ampelisca macrocephala, A. eschricti, Byblis gaimardi, Haploops* sp.); Atylidae (*Atylus*); Lysianassidae (*Anonyx*), and Haustoriidae (*Pontoporeia*) (Zimushko and Lenskaya, 1970; Bogoslovskya *et al.*, 1981; Blokhin and Pavlyuchkov, 1983, in press). A closer look at the ecology of these amphipods can provide some information on gray whale feeding.

All these species are relatively large bodied, ranging from 13 to 27 mm in length. The Ampeliscidae are tube builders and were found in dense concentrations in our samples, reaching a maximum of 937 g/m^2 and 23,780 individuals per m^2 in the Chirikov Basin. They thrive in physically disturbed, sandy sediments; on the east coast of North America ampeliscids colonize sandy bars and stabilize the bottom sediments by their network of tube dwellings (Mills, 1967). They have a short life span of 1 to 2 years (Kanneworff, 1964) and grow to maturity rapidly (Thorsen, 1957; Mills, 1967), thereby engendering a high productivity. Juvenile animals settle in uncolonized areas (Mills, 1967). Samples collected by scuba divers revealed greater numbers of newly hatched juvenile ampeliscids (3 mm in length) and larger mature adults within bottom depressions (Fig. 9). Thus, by its feeding in the Chirikov basin the gray whale may play a part in the formation of cleared areas needed by colonizing juveniles.

By contrast, species such as *Atylus* and *Anonyx*, the mobile scavenging amphipods, ordinarily do not occur in dense concentrations. In our grab samples from the Chirikov Basin, the lysianassids (of which *Anonyx* is a member) were only numerous in one sample, in which they comprised nearly 15% of the amphipods (290 individuals). In all other samples they represented less than 7% of the amphipods. *Atylus* appeared in still lower numbers and was ordinarily absent. We did note elevated concentrations of *Anonyx* in the shallow water near St. Lawrence Island swarming on small masses on detritus. As the areas shallower than 18 m are disturbed frequently by ice and are readily affected by tidal currents and wind-generated waves, it may be the nearshore areas support a mobile community of epifauna. It is therefore interesting to note that the whales which had been feeding primarily on *Anonyx* were taken only in nearshore areas along the Soviet coast (Bogoslovskya *et al.*, 1981). Similarly, *Atylus, Pontoporeia*, and *Synidothea* (an isopod) were prominent only in the stomachs of whales taken nearshore (Zimushko and Lenskaya, 1971; Bogoslovskaya *et al.*, 1981; Blokhin and Pavlyuchkov, in press). *Atylus*, like many other amphipods, annually enters the water column to breed

Table II
Genera[a] of Food Items Reported from Gray Whale Stomachs

Food item	Reference[b]	Dominance in stomach	Location of sample taken if other than Bering Sea[c]
Porifera			
Spongia	1, 20		
Hydrozoa			
Hydropolipae	1, 4, 16		
Leptolida	20		
Anthozoa			
Actinia	1, 16, 20		
Polychaeta			
Ampharetidae	20		
Brada	1		
Eunicidae	1		
Flabelligera	1		
Lumbriconereis	20		
Maldanidae	16, 20		
Nephthys	1, 20		
Onuphis	20		
Oweniidae	20		
Pectinaria	1, 2, 20		
Potamilla	20		
Sabellidae	20		
Stylarioides	1		
Terebellidae	20		
Travisia	1, 4, 20	XX[d]	
Priapulida			
Priapulus	1		
Echiura			
Echiurus	20		
Sipuncula			
Golfingia	20		
Phascolosoma	1		
Sumacea	1		
Isopoda			
Idothea	20		
Synidothea	1, 20		
Amphipoda			
Acanthostepheia	1, 3, 20		
Ampelisca	1–5, 16, 17, 20	XX	B, C
Ampithoe	20		
Anisogammarus (*Echinogammarus*)	1, 16, 20		
Anonyx	1–5, 16, 17, 20	XX	B, C
Arrhis	16		
Atylus (*Nototropis*)	1, 3, 4, 6, 16, 20	XX	
Bathymedon	20		

(*continued*)

Table II (*Continued*)

Food item	Reference[b]	Dominance in stomach	Location of sample taken if other than Bering Sea[c]
Byblis	1, 16, 20		
Caprella	20		
Corophiidae	16		
Dulichia	3, 16		
Erichthonius	20		
Eusirus	4, 16, 20	X[e]	
Haploops	1, 16, 20		
Hippomedon	1, 3, 20		
Ischyrocerus	1, 3, 16, 20		
Lembos	1, 4, 5, 16, 17, 20	X	B, C
Lepidepecreum	20		
Maera	20		
Melita	1, 17, 20		B, C
Monoculodes	16, 20		
Odius	20		
Orchomene	1, 3		
Paroediceros	1		
Paraphoxus (*Pontharpinia*)	1, 3		
Paradulichia	1		
Photis	1, 20		
Pleustes	3		
Pontoporeia	1, 4, 5, 16, 17, 20	XX	B, C
Pseudolibrotus	1		
Rhachotropis	16, 20		
Socarnes	1, 20		
Stegocephalus	1, 16, 20		
Stenopleustes	20		
Mysidacea	4, 16		
Cirripedia			
Balanus	20		
Cumacea	2, 3, 20		
Euphausiacea	15		Ca
Decapoda			
Chionocetes	1, 20		
Fabia (planktonic)	3	XX	Ca
Hyas	1, 20		
Nectocrangon	1, 20		
Nephrops (planktonic)	8	XX	K
Pachycheles (planktonic)	3	XX	Ca
Pleuroncodes (planktonic)	7		Ba
Sabinea	1		
Spirontocaris	1, 20		
Gastropoda			
Buccinidae	1, 5, 16		
Buccinidae (egg masses)	1, 4, 20		

Table II (*Continued*)

Food item	Reference[b]	Dominance in stomach	Location of sample taken if other than Bering Sea[c]
Margarites	1, 20		
Neptunea	16, 20		
Nucella	1		
Polinices	1, 2, 16		
Trichotropis	1, 20		
Velutina	1		
Bivalvia			
Hiatella	1, 20		
Macoma	1, 20		
Montacuta	1		
Musculus	1, 20		
Mya	1, 20		
Mytilus	1		
Serippes	1, 20		
Holothuroidea			
Cucumaria	1, 20		
Unidentified	2, 3, 16		
Ascidiacea			
Dendrodoa	1		
Pelonaia	1, 20		
Sijnascidia	1		
Unidentified	2, 3, 16, 20		
Pisces			
Ammodytidae	1		
Clupeidae	9, 10, 11	XX	Ba, W
Plant material	1, 5, 4, 125, 13, 14, 16, 185, 195	XX	B, W, Ba, K, Ca
Mud, sand, silt, gravel	1, 4, 2, 3, 125, 6		

[a]Note that only italicized names are genera. Other categories are family, order, class, or phylum.

[b]Sources (S denotes information from a stranded whale)

(1) Zimushko and Lenskaya, 1970 (n = 70).
(2) Pike, 1962 (n = 3).
(3) Rice and Wolman, 1971 (n = 317).
(4) Tomilin, 1957 (n = 57).
(5) Zenkovich, 1934 (n = 2).
(6) Zenkovich, 1937 (n = 192).
(7) Matthews, 1932 (n = 1).
(8) Mizue, 1951 (n = 545).
(9) Klumov, 1963 (n = 1).
(10) Walker, 1949 (n = 1).
(11) Balcomb, personal communication (n = 1).
(12) Nerini, unpublished data (n = 3).
(13) Scammon, 1874 (n = several).
(14) Andrews, 1914 (n = unknown).
(15) Howell and Huey, 1930 (n = 1).
(16) Bogoslovskaya *et al.*, 1981 (n = 113).
(17) Coyle, 1981 (n = 1).
(18) Jones, personal communication (n = 1).
(19) Harvey, personal communication (n = 1).
(20) Blokhin and Pavlyuchkov, in press (n = 120).

[c]B, Bering Sea; C, Chukchi Sea; Ba, Baja; Ca, California; W, Washington; K, Korea.

[d]XX, comprised >40% by volume in at least one stomach.

[e]X, frequent occurrence, not dominating.

(C. Staude, personal communication) and perhaps it is at this time that the whales consume them. In 1980 we noted a cloud of juvenile *Atylus* sp. distributed from the surface to the bottom in water 9 m deep. In our samples, *Pontoporeia femorata* was found only in water shallower than 34 m, where in one sample it reached a maximum of 49% (3618 individuals) of the total amphipods.

The composition of the prey items taken by gray whales, as evidenced by stomach contents, is similar to the benthic infaunal composition observed in the area of catch. For example, stomach contents of whales taken in Soviet whaling area 12 (the Chirikov basin) consisted of ampelisciid amphipods (95%), *Lembos* spp. (3%), and *Anonyx* spp. (2%) (Bogoslavskaya *et al.*, 1981). Our westernmost grab sample in the Chirikov basin contained ampelisciid amphipods (95%), *Lembos* spp. (1.8%), and *Anonyx* spp. (0.3%). Assuming the gray whale does suck up sediments and associated fauna, one might reasonably expect heavier organisms such as the large or deep-living bivalves which are present in the community (e.g., *Serripes* and *Mya* spp.) to be underrepresented in the stomach contents, as they are. Thus, the extraordinary diversity of prey items displayed in Table II is merely a by-product of the whales' inability to sort out perhaps less desirable or rare items occurring with their preferred prey. Some selection based on size and shape of the prey may occur due to the coarseness or "sieve size" of the baleen. Rice and Wolman (1971) measured prey items varying from 6 to 25 mm in length, and Coyle (1981) only found items 8–10 mm. I have measured crab zoae collected from the stomach of a migrating whale which were 3 mm in length. The shape of the organism

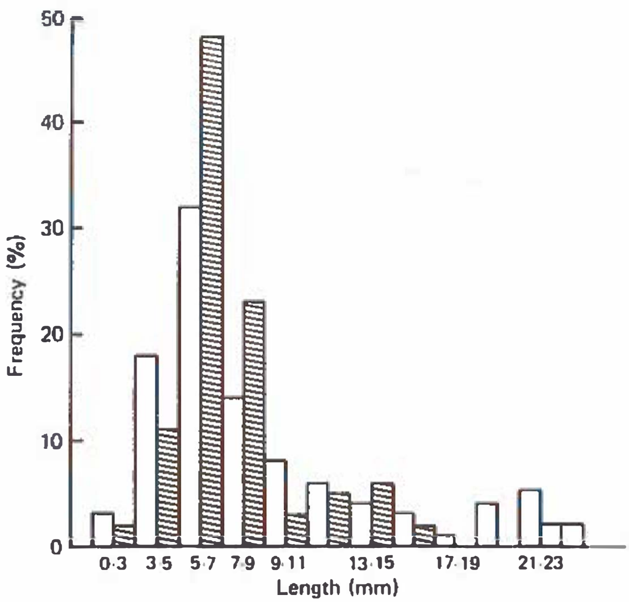

Fig. 9. *Length frequency distribution of amphipod* Ampelisca macrocephala, *taken inside (white bars) and outside (shaded bars) of a feeding depression in July 1980, off Southeast Cape, St. Lawrence Island.*

may be as important as its size; Those animals with many appendages are more likely to be snared by the baleen than relatively smooth-bodied items such as polychaetes.

The planktonic items known to have been eaten by gray whales (Table II) occur in swarms or schools. Their presence in a stomach is usually exclusive of any other species, and they only occur in stomachs of whales taken or stranded south of the Bering Sea.

Plant material has also been reported from the stomachs of gray whales. Most authors, excepting Tomilin (1957), have discounted the value of plant material and attributed its presence among the prey items to incidental ingestion. I suggest that ingestion of plant material may at least in some cases be deliberate. It appears frequently in the stomach contents, sometimes in large quantities. For example, 120 liters of kelp (*Laminaria* sp.) and algae were found in the stomach of a gray whale stranded at Wauna, Washington (personal observations) and a lesser amount associated with unidentified crustaceans was found in the stomach of a whale stranded at Neah Bay, Washington. Although stranded animals are not representative of normal animals, the quantity of plant material found in this case suggests it was not an accidental ingestion. Plant material is also found in normal animals. Bogoslavskya *et al.* (1981) reported that as much as 35% of a stomach of a whale harvested in the Bering Sea was filled with algae, and Scammon (1874) reported most stomachs of gray whales in the Baja lagoons contained a "sea moss," which I assume was eelgrass. Andrews (1914) states that every stomach examined from Korea was filled with dark green water containing bits of kelp and sea grass. Fecal material in these whales was dark green and the consistency of thick cream. Recent analyses of three samples from three stranded gray whales for the occurrence of seven volatile fatty acids has revealed significant amounts of acetic, propionic, and butyric acids (Herwig *et al.*, 1984). The levels of these compounds, found in the forestomachs, could be produced only during microbial fermentation. One of the stomachs tested contained only kelp; thus, although microbial fermentation has not been previously described in cetaceans, there is some evidence that this process occurs in the stomach. Such a process would allow the gray whale to obtain an undetermined amount of energy from plant material, rendering the whale a partial facultative herbivore.

Rates of Consumption

No discussion of the feeding ecology of the gray whale would be complete without attention, however sketchy, to the energetics of the whale and the total amount of food consumed by the population. As discussed, the gray whale does not feed solely in arctic waters; however, for simplicity and because of our ignorance about the extent of feeding in southern waters, I assume that most of the annual food ration is taken in the Bering and Chukchi Seas. Migrating whales weigh more when taken on the southward leg of their annual journey than they do on the northward leg (Rice and Wolman, 1971). Much of this weight increase is attributable to fat stored in the tissues—in fact, there is no appreciable increase in blubber thickness (Rice and Wolman, 1971)—and this can be measured very grossly by the total oil content.

During the approximately 5 months between the northward and southward migration (June–October), a gray whale is estimated to gain, on an average, 5,063 kg in rendered oil (Rice and Wolman, 1971), or about 16–30% of its body weight. If we assume that the predominant prey are benthic amphipods, which have a lipid content of 7–22% (Percy and Fife, 1981)[2] and that only the lipid fraction of the prey is diverted to fat storage with an associated transfer efficiency of 75% (cf. Brodie, 1975), one whale will ingest, conservatively, an estimated minimum of 61,370 kg of prey during the five months. If we further assume that only 3 of the 5 summer months are spent feeding in the Bering Sea and the remaining 2 are spent feeding in the Chukchi Sea, then the average gray whale may be predicted to remove 36,821 kg/year (409 kg/day) from the Bering Sea sediments. Since the mean amphipod biomass observed in the whale foraging area was 161 g/m^2, to obtain the predicted ration from the Bering Sea an average whale would need to remove the amphipods from 228,707 m^2 (57 acres) of sediment. The entire population, conservatively estimated at over 15,500 gray whales, would then turn over 3,565 km^2/yr of sea bottom or an estimated 9% of the available amphipod community (Fig. 7). Zimushko and Lenskaya (1971) estimated the average adult gray whale consumed 1,200 kg/day.[3] If we substitute that figure for 409 kg/day in the preceding calculation, the estimated bottom consumption is 27% of the total available. If, however, we substitute into the preceding model Stoker's (1978) figures on the average total biomass, for this region of 498 g/m^2, then the whales consume 9% of the total available benthos.

Frost and Lowry (1981) and Rice and Wolman (1971) made similar calculations and arrived at annual consumptions of 0.3–2 and 0.2–1% respectively, of the total standing stock of the benthos. However, the first estimates were based on a total summer range of 1×10^6 km^2, an area several orders of magnitude greater than the circumscribed amphipod community. Lastly, Nelson *et al.* (1981) calculated from their side-scan data that at a minimum, 3.4% of the Chirikov basin shows evidence of recent feeding disturbance. Without better data on the parameters involved in the calculations, it is difficult to determine which of the estimates is more realistic. In any case, the gray whale must be viewed as having a significant impact on the benthic community.

Conclusions

The population of gray whales relies primarily upon the shallow benthic communities of the northern seas for its annual food supply. But the importance of peripheral feeding areas is less clear, and many questions relating to the distribution of the

[2]This was reported as 7–22% of the dry weight of the amphipods, which converts to 5–16% of the net weight. Thus I have considered 11% as the average lipid content and used it in the ensuing calculations.

[3]Rice and Wolman (1971) and Brodie (1975) separately calculated daily food rations of 1 metric ton/day for large cetaceans.

southern food resources and the metabolic needs of the "resident" whale populations are unanswered. Taking the recent sightings of whales feeding in southern waters into account, it now seems likely that the winter fast is broken by ancillary feeding on schools of bait fish or pelagic resources inside and outside the breeding lagoons.

The prey items themselves are generally organisms found naturally in large aggregations. Like other animals that consume prey much smaller than themselves, the cost to the gray whale of catching and handling their prey is small relative to the cost of finding enough of the prey species. Consequently, whales rely on locating patches of prey items (cf. Brodie *et al.*, 1978). It is not surprising therefore that several of the staple prey items, for example, *Ampelisca* and *Photis* spp., are pioneer species capable of recruiting quickly onto unoccupied substrate and also capable of growing rapidly into nearly monospecific assemblages. It is not known how the whales locate patches of food, or how completely they may utilize a patch before continuing on their way. The gray whale may be unusual among whales in that, in addition to being an important predator, it is also a major source of physical disturbance to the exploited community. In concert with currents, sea ice, and storm waves, the gray whale may be responsible for clearing space which can be later colonized by the prime prey species. In this way, it may help to maintain the very amphipod community it exploits.

Finally, perhaps the most extraordinary aspect of the gray whale's feeding ecology is its apparent dietary flexibility. For an animal which has developed highly specialized feeding structures such as baleen, the gray whale has remained a generalist. If trophic specialization is in fact a selective disadvantage as Fowler and MacMahon (1982) argue, then perhaps it is for this reason that the Pacific gray whale population has persisted through geologic time, has recovered from severe exploitation, and remains today one of the least endangered of the great whales.

Summary

Data on feeding gray whales (*Eschrictius robustus*) collected during a 1980 research cruise in the northern Bering Sea are combined with published and unpublished observations to produce a more comprehensive view of gray whale feeding ecology. This review discusses feeding mechanisms, feeding areas, prey items, and rates of food consumption. Although the gray whale population relies primarily upon the benthic communities of northern seas for its annual food ration, peripheral areas and pelagic resources are also exploited. Calculation of food consumption in the northern Bering Sea is estimated to be 3.4–27% of the available benthic community.

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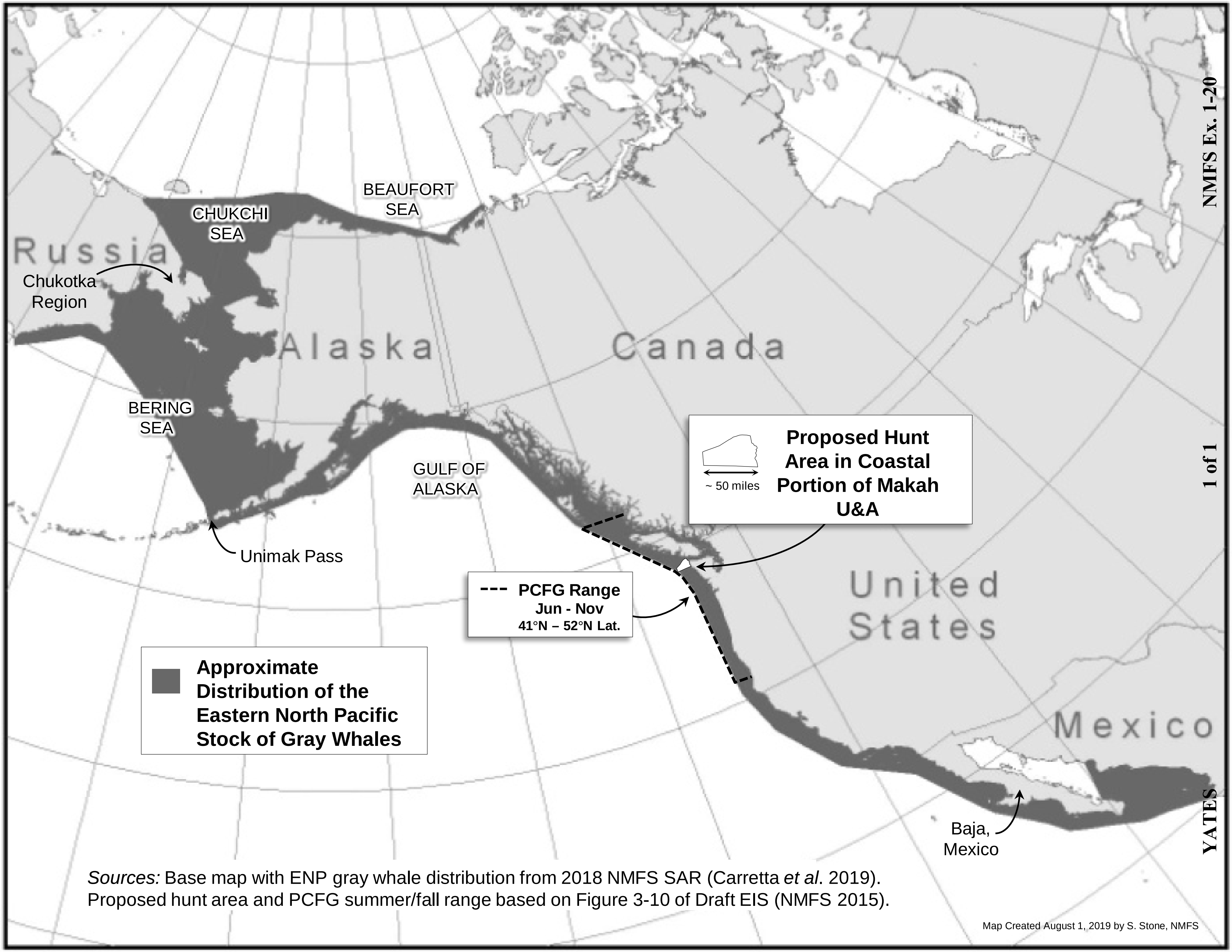

Sources: Base map with ENP gray whale distribution from 2018 NMFS SAR (Carretta *et al*. 2019). Proposed hunt area and PCFG summer/fall range based on Figure 3-10 of Draft EIS (NMFS 2015).