Revisions to Guidelines for Assessing Marine Mammal Stocks (GAMMS II)

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The initial guidelines (Barlow *et al*., 1995) and first revision of the guidelines for assessing marine mammal stocks (Wade and Angliss, 1998) were each published as an appendix to a NOAA Technical Memorandum. In these two cases, the publications were reports of workshops convened to discuss guidance for preparing stock assessment reports.

A similar workshop was convened for these revisions; however, no report was prepared describing the workshop. This revision originated in a meeting of NMFS and FWS scientists and managers, accompanied by representatives of the three regional Scientific Review Groups. The revised guidelines were subjected to review by NMFS scientists and managers and members of the Scientific Review Group. The revised guidelines were processed through NMFS and NOAA General Counsel clearance and approved by the Assistant Administrator for Fisheries to be released to the public for review and comment (69 FR 67541, November 18, 2004). NMFS updated the guidelines as needed in accordance with public comment, summarized comments received on these revised guidelines and responded to these summary comments. The final revised guidelines and summarized comments with responses received NMFS and NOAA General Counsel review and clearance prior to approval by the Assistant Administrator for Fisheries for use and release to the public (70 FR 35397, June 20, 2005). Accordingly, these revised guidelines represent a statement of NMFS policy for implementing provisions of section 117 of the Marine Mammal Protection Act.

Guidelines for Preparing Stock Assessment Reports Pursuant to Section 117 of the Marine Mammal Protection Act

1. General Guidelines

Introduction

Sec. 117 of the Marine Mammal Protection Act (MMPA) requires that the National Marine Fisheries Service (NMFS) and the Fish and Wildlife Service (FWS) develop Stock Assessment Reports (Reports) for all marine mammal stocks in waters under U.S. jurisdiction (U.S. waters). These Reports are to be based upon the best scientific information available. Reports are not required for stocks that have a remote likelihood of occurring regularly in U.S. waters (e.g., stocks for which only the margins of the range extends into U.S. waters or that enter U.S. waters only during anomalous current or temperature shifts).

The MMPA requires Reports to include, among other things, information on how stocks were identified, a calculation of Potential Biological Removal (PBR), and an assessment of whether incidental fishery takes are "insignificant and approaching zero mortality and serious injury rate". These reports are to be reviewed annually for "strategic stocks" and for stocks for which new information is available, and at least once every three years for all other stocks. This document provides guidance for how these topics are to be addressed in the Reports.

The MMPA provides some general guidance for developing the Reports; more detailed guidelines were developed at the PBR Workshop in June 1994 and were used in writing the original draft Reports. The guidelines for preparing SARs were initially drafted as the result of a workshop in 1994. The draft guidelines and initial draft stock assessment reports were subjected to public review and comment in August 1994. Final guidelines and reports were completed in 1995 (Barlow et al. 1995). In 1996, representatives of NMFS, FWS, regional Scientific Review Groups, and the Marine Mammal Commission reviewed the guidelines, and NMFS proposed minor changes in 1996. The revised guidelines, after public review and comment, were made final in 1997 (Wade and Angliss 1997) and have been used since that time. In September 2003, NMFS again convened representatives of the review groups and agencies to review and, as appropriate, recommend revisions to the guidelines.

It is anticipated that the guidelines themselves will be reviewed and changed based on additional scientific research and on experience gained in their application. In this regard, FWS and NMFS will meet periodically to review and revise, as needed, the guidelines. When the agencies recommend revisions to the guidelines, these revisions will be made available for public review and comment prior to acceptance. Furthermore, the guidelines in this document do not have to be followed rigidly; however, any departure from these guidelines must be discussed fully within any affected Report.

The intent of these guidelines is to: (1) provide a uniform framework for the consistent application of the amended MMPA throughout the country; (2) ensure that PBR is calculated in a manner that ensures meeting the goals of the MMPA; (3) provide guidelines for evaluating whether fishery takes are insignificant and approaching a zero mortality and serious injury rate; and (4) make the Government's approach clear and open to the public. Where the guidelines provided here are not incorporated into a particular Report, it was agreed that justification for the departure will be provided within the Report. Similarly, the Reports will explain when deviations are made from specific recommendations from the Scientific Review Groups.

FWS and NMFS interpret the primary intent of the 1994 MMPA amendments and the PBR guidelines developed pursuant to the Act as a mechanism to respond to the uncertainty associated with assessing and reducing marine mammal mortality from incidental fisheries takes. Accordingly, this mechanism is increasingly conservative under increasing degrees of uncertainty. The MMPA requires the calculation of PBR for all stocks, including those that are considered endangered under the Endangered Species Act (ESA) and those which are managed under other authorities, such as the International Whaling Commission. However, in some cases allowable takes under these other authorities may be less than the PBR calculated under the MMPA owing to the different degrees of "risk" associated with, and the treatment of, uncertainty under each authority. Where there is inconsistency between the MMPA and ESA regarding the take of listed marine mammals, the more restrictive mortality requirement takes precedence. Nonetheless, PBR must still be calculated for these stocks, where possible, and discussed in the text of the Reports. As mandated in the MMPA, the PBR is calculated as "...the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population." Therefore, a PBR is an upper limit to removals that does not imply that the entire amount should be taken.

Estimates of PBR, human-caused mortality, and classification as to whether a stock is "strategic" or "non-strategic" are required by Sec. 117 to be included in the Reports for all stocks of marine mammals in U.S. waters. However, it should be noted that the co-management, between the Federal government and Alaska Native organizations, of removals of marine mammals for subsistence purposes between the Federal government and Alaska Native organizations is specifically addressed in Sec. 119. In response to Sec. 119, NMFS and FWS have entered into cooperative agreements with Alaska Native organizations to conserve marine mammals and provide co-management of subsistence use by Alaska Natives. FWS and NMFS believe that it is appropriate to develop management programs for stocks subject to subsistence harvests through the co-management process provided that commercial fisheries takes are not significant and that the process includes a sound research and management program to identify and address uncertainties concerning the status of these stocks. Estimates of PBR and classification as to whether a stock is strategic will be determined from the analysis of scientific and other relevant information discussed during the co-management process.

Definition of "Stock"

"Population stock" is the fundamental unit of legally-mandated conservation. The MMPA defines population stock as "a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature." To fully interpret this definition, it is necessary to consider the objectives of the MMPA. In Sec. 2 (Findings and Declaration of Policy) of the MMPA it is stated that "...species and populations stocks of marine mammals...should not be permitted to diminish beyond the point at which they cease to be a significant functioning element in the ecosystem of which they are a part, and, consistent with this major objective, they should not be permitted to diminish below their optimum sustainable population." Further on in Sec. 2, it states "...the primary objective of their management should be to maintain the health and stability of the marine ecosystem. Whenever consistent with this primary objective, it should be the goal to obtain an optimum sustainable population keeping in mind the carrying capacity of the habitat." Therefore, stocks must be identified in a manner that is consistent with these goals. For the purposes of management under the MMPA, a stock is recognized as being a management unit that identifies a demographically isolated biological population. It is recognized that in practice, identified stocks may fall short of this ideal because of a lack of information, or for other reasons.

Many types of information can be used to identify stocks of a species: *e.g.*, distribution and movements, population trends, morphological differences, differences in life history, genetic differences, contaminants and natural isotope loads, parasite differences, and oceanographic habitat differences. Different population responses (e.g., different trends in abundance) between geographic regions is also an indicator of stock structure, as populations with different trends are not strongly linked demographically. When different types of evidence are available to identify stock structure, the report must discuss inferences made from the different types of evidence and how these inferences were integrated to identify the stock.

Evidence of morphological or genetic differences in animals from different geographic regions indicates that these populations are reproductively isolated. Reproductive isolation is proof of demographic isolation, and, thus, separate management is appropriate when such differences are found. Demographic isolation means that the population dynamics of the affected group is more a consequence of births and deaths within the group (internal dynamics) rather than immigration or emigration (external dynamics). Thus, the exchange of individuals between population stocks is not great enough to prevent the depletion of one of the populations as a result of increased mortality or lower birth rates.

Failure to detect differences, however, does not mean that populations are not demographically or reproductively isolated. Dispersal rates, though sufficiently high to homogenize morphological or genetic differences detectable between putative populations, may still be insufficient to deliver enough recruits from an unexploited population (source) to an adjacent exploited population (sink) so that the latter remains a functioning element of its ecosystem.

Insufficient dispersal between populations where one bears the brunt of exploitation coupled with their inappropriate pooling for management could easily result in failure to meet MMPA objectives. For example, it is common to have human-caused mortality restricted to a portion of a species' range. Such concentrated mortality (if of a large magnitude) could lead to population fragmentation, a reduction in range, or even the loss of undetected populations, and would only be mitigated by high immigration rates from adjacent areas.

Therefore, careful consideration needs to be given to how stocks are identified. In particular, where mortality is greater than a PBR calculated from the abundance just within the oceanographic region where the human-caused mortality occurs, serious consideration should be given to identifying an appropriate management unit in this region. In the absence of adequate information on stock structure and fisheries mortality, a species' range within an ocean should be divided into stocks that represent defensible management units. Examples of such management units include distinct oceanographic regions, semi-isolated habitat areas, and areas of higher density of the species that are separated by relatively lower density areas. Such areas have often been found to represent true biological stocks where sufficient information is available. In cases where there are large geographic areas from which data on stock structure of marine mammals are lacking, stock structure from other parts of the species' range may be used to draw inferences as to the likely geographic size of stocks. There is no intent to identify stocks that are clearly too small to represent demographically isolated biological populations, but it is noted that for some species genetic and other biological information has confirmed the likely existence of stocks of relatively small spatial scale, such as within Puget Sound, WA, the Gulf of Maine, or Cook Inlet, AK.

In trans-boundary situations where a stock's range spans international boundaries or the boundary of the U.S. Exclusive Economic Zone (EEZ), the best approach is to establish an international management agreement for the species. In the interim, if a stock is migratory and it is reasonable to do so, the fraction of time in U.S. waters should be noted, and the PBR for U.S. fisheries should be apportioned from the total PBR based on this fraction. In a non-migratory situation, the PBR for U.S. fisheries should be calculated based on the abundance estimate of the stock residing in U.S. waters. For situations where a species with a broad pelagic distribution which extends into international waters experiences mortalities within the U.S. EEZ, PBR calculations should be based on the abundance in the EEZ. If there is evidence for movement of individuals between the EEZ and offshore pelagic areas and there are estimates of mortality from US and other sources throughout the stock's range, then PBR calculations may be based upon a range-wide abundance estimate for the stock.

Prospective Stocks

When information becomes available that appears to justify a different stock structure or stock boundaries, it may be desirable to include the new structure or boundaries as "prospective stocks" within the existing report. The descriptions of prospective stocks would include a description of the evidence for the new stocks, calculations of the prospective PBR for each new stock, and estimates of human-caused mortality and serious injury, by source. The notice of

availability of draft reports with prospective stocks would include a request for public comment and additional scientific information specifically addressing the prospective stock structure. Prospective stocks would be expected to become separate stocks in a timely manner unless additional evidence were produced to contradict the prospective stock structure. Summary information for prospective stocks should be included in the standard table in the SARs that summarizes Nmin, Rmax, etc. for each stock.

PBR Elements

The 1994 amendments to the MMPA mandate that, as part of the Reports, PBR estimates must be developed for each marine mammal stock in U.S. waters. The PBR is defined as "the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population." In addition, the MMPA states that PBR is calculated as the product of three elements: the minimum population estimate (N_{min}); half the maximum net productivity rate (0.5 R_{max}); and a recovery factor (F_r). The guidelines for defining and applying each of these three elements are described below. Further specific guidance on the calculation of PBR is provided in part 2 (Technical Details) of this document.

In unusual situations, the formula Congress added to the MMPA to calculate PBR (Nmin*0.5Rmax*Fr) results in a number that is not consistent with the narrative definition of PBR (the maximum number of animals, not including natural mortality, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its OSP). An underlying assumption in the application of the PBR equation is that marine mammal stock exhibit certain dynamics. Specifically, it is assumed that a depleted stock will naturally grow toward OSP and that some surplus growth may be removed while still allowing recovery. Such a situation arises when a stock is below its OSP and is declining or stable, yet human-caused mortality is a not a major factor in the population's trend. Thus, for unknown reasons, the stock's dynamics do not conform to the underlying model for calculating PBR.

For example, Hawaiian monk seals are endangered, declining, and below OSP (based upon the abundance prior to the 1970s), yet human-caused mortality is insufficient to account for the decline or a failure to increase. A limited removal would not reduce the population's ability not reach or maintain its OSP after the major factors affecting the stock have been identified and addressed. Therefore, in these unusual situations, NMFS may report PBR as "undetermined".

Minimum Population Estimate (N_{min})

N_{min} is defined in the MMPA amendments as an estimate of the number of animals in a stock that:

> "(A) is based on the best available scientific information on abundance, incorporating the

precision and variability associated with such information; and,

(B) provides reasonable assurance that the stock size is equal to or greater than the estimate."

Consistent with these MMPA definitions, N_{min} should be calculated such that a stock of unknown status would achieve and be maintained within OSP with 95% probability. Population simulations have demonstrated (Wade 1994) that this goal can be achieved by defining N_{min} as the 20th percentile of a log-normal distribution based on an estimate of the number of animals in a stock (which is equivalent to the lower limit of a 60% 2-tailed confidence interval):

$$N_{min} = N/\exp(0.842 * (\ln(1+CV(N)^2))^{1/2}) \qquad (1)$$

where N is the abundance estimate and CV(N) is the coefficient of variation of the abundance estimate. If abundance estimates are believed to be biased, appropriate correction factors should be applied to obtain unbiased estimates of N. In such cases, the coefficient of variation for N should include uncertainty in the estimation of the correction factor. In cases where a direct count is available, such as for many pinniped stocks, this direct count could alternatively be used as the estimate of N_{min}. Other approaches could also be used to estimate N_{min} if they provide the same level of assurance that the stock size is equal to or greater than that estimate.

Clearly, projections of current abundance estimates become less dependable with time after a survey has occurred. When abundance estimates become many years old, at some point estimates will no longer meet the requirement that they provide reasonable assurance that the stock size is presently greater than or equal to that estimate. Therefore, unless compelling evidence indicates that a stock has not declined since the last census, the minimum population estimate of the stock should be considered unknown if 8 years have transpired since the last abundance survey of a stock. Eight years was chosen, in part, because a population that declines at 10% per year from carrying capacity would be reduced to less than 50% of its original abundance after 8 years. A 10% decline per year over at least 8 years represents the greatest decline observed for a stock of marine mammals in U.S. waters. If N_{min} is unknown, then PBR cannot be determined, but this is not equivalent to considering PBR equal to zero. If there is known or suspected human-caused mortality of the stock, decisions about whether such stocks should be declared strategic or not should be made on a case-by-case basis. Stocks for which N_{min} becomes unknown should not move from "strategic" to "not-strategic", or v.v., solely because of an inability to estimate N_{min}.

Maximum Rate of Increase (R_{max})

One-half R_{max} is defined in the MMPA as "one-half of the maximum theoretical or estimated 'net productivity rate' of the stock at a small population size", where the term “net productivity rate” means “the annual per capita rate of increase in a stock resulting from additions due to reproduction, less losses due to natural mortality."

Default values should be used for R_{max} in the absence of stock-specific measured values. To be consistent with a risk-averse approach, these default values should be near the lower range of measured or theoretical values (or 0.12 for pinnipeds and sea otters and 0.04 for cetaceans and manatees). Substitution of other values for these defaults should be made with caution, and only when reliable stock-specific information is available on R_{max} (e.g., estimates published in peer-reviewed articles or accepted by review groups such as the MMPA Scientific Review Groups or the Scientific Committee of the International Whaling Commission).

Details on rounding and precision, and on averaging more than one estimate of abundance to calculate N_{min}, can be found in part 2 of this document.

Recovery Factor (F_r)

The MMPA defines the recovery factor, F_r, as being between 0.1 and 1.0. The intent of Congress in adding F_r to the definition of PBR was to ensure the recovery of populations to their OSP levels, and to ensure that the time necessary for populations listed as endangered, threatened, and depleted to recover was not significantly increased. The use of F_r less than 1.0 allocates a proportion of expected net production towards population growth and compensates for uncertainties that might prevent population recovery, such as biases in the estimation of N_{min} and R_{max} or errors in the determination of stock structure. Population simulation studies demonstrate that the default F_r for stocks of endangered species should be 0.1, and that the default F_r for depleted and threatened stocks and stocks of unknown status should be 0.5. The default status should be considered as "unknown". Stocks known to be within OSP (e.g., as determined from quantitative methods such as dynamic response or back-calculation), or stocks of unknown status that are known to be increasing, or stocks that are not known to be decreasing taken primarily by aboriginal subsistence hunters, could have higher F_r values, up to and including 1.0, provided that there have not been recent increases in the levels of takes. Recovery factors for listed stocks can be changed from their default values, but only after careful consideration and where available scientific evidence confirms that the stock is not in imminent danger of extinction. Values other than the defaults for any stock should usually not be used without the approval of the regional Scientific Review Group, and scientific justification for the change should be provided in the Report.

The recovery factor can be adjusted to accommodate additional information and to allow for management discretion as appropriate and consistent with the goals of the MMPA. For example, if human-caused mortalities include more than 50% females, the recovery factor should be decreased to compensate for the greater impact of this mortality on the population (or increased if less than 50% female). Similarly, declining stocks, especially ones that are threatened or depleted, should be given lower recovery factors, the value of which should depend on the magnitude and duration of the decline. The recovery factor of 0.5 for threatened or depleted stocks or stocks of unknown status was determined based on the assumption that the coefficient of variation of the mortality estimate is equal to or less than 0.3. If the CV is greater than 0.3, the recovery factor should be decreased to: 0.48 for CVs of 0.3 to 0.6; 0.45 for CVs of 0.6 to 0.8;

and 0.40 for CVs greater than 0.8.

Recovery factors could also be increased in some cases. If mortality estimates are known to be relatively unbiased because of high observer coverage, then it may be appropriate to increase the recovery factor to reflect the greater certainty in the estimates. Thus, in an instance where the observer coverage was 100% and the observed fishery was responsible for virtually all fishery mortality on a particular stock, the recovery factor for a stock of unknown status might be increased from 0.5 (reflecting less concern about bias in mortality, but continued concern about biases in other PBR parameters and errors in determining stock structure). Recovery factors of 1.0 for stocks of unknown status should be reserved for cases where there is assurance that N_{min}, R_{max}, and the kill are unbiased and where the stock structure is unequivocal.

Annual human-caused mortality and serious injury

The Reports should contain a complete description of what is known about current human-caused mortality and serious injury. Information about incidental fisheries mortality should be provided, including sources such as observer programs, logbooks, fisher's reports, strandings, and other sources, where appropriate. It is expected that this section of the Reports will include all pertinent information that is subsequently used to categorize fisheries under Sect. 118. Therefore, any additional information that is anticipated to be used to categorize a fishery should be provided here.

In general, the most recent appropriate information about annual human-caused mortality and serious injury ("annual mortality") should be used. If mortality estimates are available for more than one year, a decision will have to be made about how many years of data should be used to estimate annual mortality. There is an obvious trade-off between using the most relevant information (the most recent data) versus using more precise information (pooling across a number of years). It is recognized that it is inappropriate to give one specific rule defining which years of data should be used, as this depends upon the quality and quantity of data available in each case. It is suggested that mortality estimates could be averaged over as many years necessary to achieve a CV of less than or equal to 0.3, but should usually not be averaged over a time period of more than the most recent 5 years for which data have been analyzed. However, information that is more than 5 years old should not be ignored if it is the most appropriate information available in a particular case. Also, in some cases it may not be appropriate to average over as many as 5 years even if the CV of an estimate is greater than 0.3. For example, if it is known that within the last 5 years the amount of total fishing effort has changed substantially, or the mortality rate per unit of fishing effort has changed substantially, it will probably be most appropriate to use only the most recent relevant data to most accurately reflect the current level of annual mortality. When mortality is averaged over years, it is recommended that an un-weighted average be used, as it is possible and likely that true mortality varies from year-to-year.

In some cases, mortality occurs in areas where more than one stock of marine mammals occurs.

When biological information (e.g., genetics, morphology) is sufficient to identify the stock from which a dead animal came, then the mortality should be associated only with that stock. When a dead animal cannot be assigned directly to a stock, then mortality may be partitioned by the abundances of the stocks vulnerable to the mortality (i.e., based on the abundances of each stock within the appropriate geographic area), provided there is sufficient information on stock abundance. When mortality is partitioned among overlapping stocks proportional to the abundances of the affected stocks, the reports will contain a discussion of the potential for over- or under-estimating stock-specific mortality.

A summary of incidental fisheries mortality and serious injury should be presented in a table, providing the name of the fishery, the current number of vessels, and for each appropriate year, observed mortality, estimated extrapolated mortality and serious injury and its CV, and percent observer coverage in that year, with the last column providing the average annual mortality estimate for that fishery. Information should be provided (in either the table or the text) about the number of mortalities and the number of injuries, and what injuries are considered "serious" (i.e., leading to mortality), if any. For fisheries without observer programs, information about incidental mortality from logbooks, fisher's reports, strandings, and other sources should be listed instead, where appropriate. Such information should be presented in brackets to distinguish it from actual estimates of total mortality in the fishery. All fisheries listed as interacting with the stock in the List of Fisheries should be listed in the table with as much information as possible. Further guidance, including a sample table, is provided in the third section of these guidelines.

It is often difficult to determine if an injury is serious or not. Stocks which have estimated known mortality (not including injuries) that is less than PBR but have total estimated mortalities and injuries that is greater than PBR (or similarly which have estimated known mortality that is less than 10% of PBR but have total estimated mortalities and injuries that is greater than 10% of PBR) should be clearly identified. Research to determine which injuries are serious will be necessary for such stocks. If injuries have been determined to be serious, the Report should indicate how this determination was made.

There is a general view that marine mammal mortality information from logbook or fisher report data can only be considered as a minimum estimate of mortality, although exceptions may occur. Logbook or fisher report information can be used to determine whether the minimum mortality is greater than the PBR (or greater than 10% of the PBR), but it should not be used to determine whether the mortality is less than the PBR (or 10% of the PBR). Logbook data for fisher reports should not be used as the sole justification for determining that a particular stock is not strategic or that its mortality and serious injury rate is insignificant and approaching zero rate.

Further guidance on averaging human-caused mortality across years and across different sources of mortality can be found in part 2 (Technical Details) of this document.

Mortality Rates

Sec. 118 of the 1994 MMPA Amendments reaffirmed the goal set forth in the Act when it was enacted in 1972 that the take of marine mammals in commercial fisheries is to be reduced to insignificant levels approaching zero mortality and serious injury rate, and further requires that this goal be met within 7 years of enactment of the 1994 Amendments (April 30, 2001). This fisheries-specific goal is referred to as the "zero mortality rate goal" (ZMRG). The Stock Assessment Reports are not the vehicle for publishing determinations as to whether a specific fishery has achieved the ZMRG. A review of progress towards the ZMRG for all fisheries is required to be submitted to Congress by April 30, 1998.

However, Sec. 117 of the amended MMPA does require that stock assessment reports include descriptions of fisheries that interact with (i.e., kill or seriously injure) marine mammals, and these descriptions must contain "an analysis stating whether such level is insignificant and is approaching a zero mortality and serious injury rate." As a working definition for the Reports, this analysis should be based on whether the total mortality for a stock in all commercial fisheries with which it interacts is less than 10% of the calculated PBR for that stock. The following wording is recommended:

"The total fishery mortality and serious injury for this stock is (or is not) less than 10% of the calculated PBR and, therefore, can (or cannot) be considered to be insignificant and approaching a zero mortality and serious injury rate."

Status of Stocks

This section of the Reports should present a summary of 4 types of "status": 1) current legal designation under the MMPA and ESA, 2) status relative to OSP (within OSP, depleted, or unknown), 3) designation of strategic or non-strategic, and 4) a summary of trends in abundance and mortality.

The MMPA requires a determination of a stock's status as being either strategic or non-strategic and does not allow for a category of unknown. If abundance or human-related mortality levels are truly unknown (or if the fishery-related mortality level is only available from logbook data), some judgement will be required to make this determination. If the human-caused mortality is believed to be small relative to the stock size based on the best scientific judgement, the stock could be considered as non-strategic. If human-caused mortality is likely to be significant relative to stock size (e.g., greater than the annual production increment) the stock could be considered as strategic. In the complete absence of any information on sources of mortality, and without guidance from the Scientific Review Groups, the precautionary principle should be followed and the default stock status should be strategic until information is available to demonstrate otherwise.

The MMPA requires for strategic stocks a consideration of other factors that may be causing a decline or impeding recovery of the stock, including effects on marine mammal habitat and prey. Therefore, such issues should be summarized in the Status section for all strategic stocks. If

substantial issues regarding the habitat of the stock are important, a separate section titled "Habitat Issues" should be used. If data exist that indicate a problem, they should be summarized and included in the Report. If there are no known habitat issues or other factors causing a decline or impeding recovery, this should be stated in the Status section.

References

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2. Technical Details

In this section, technical details are given for making appropriate calculations of PBR and mortality. The first section provides details on precision and rounding issues. The second section provides details for combining more than one abundance estimate for calculating $N_{MIN.}$ The third section contains details for calculating the estimate of annual human caused mortality and its associated variance.

Precision and Rounding

The following rules on precision and rounding should be applied when calculating PBR and other values:

(a) N (the abundance estimate), CV(N), R_{max}, and F_r should be reported in the Report to whatever precision is thought appropriate by the authors and involved scientists, so long as what is reported is exactly what the PBR calculation is based on.
(b) PBR should be calculated from the values for (a) to full precision, and not be calculated from an intermediary rounded off N_{min}. However, N_{min} should be reported as a rounded integer.
(c) PBR and mortality should be reported with one decimal place if they are below 10. Otherwise, PBR and mortality should be reported as a rounded integer.
(d) If PBR and mortality round to the same integer, the Report will report both values to the precision necessary to determine which is larger. This would also be done if 10% of PBR and mortality round to the same integer.

Computation of Average Abundance and its Variance

When estimates of abundance are available for more than one year or from more than one source in the same year, it may be appropriate to combine those estimates into an average abundance for the time period in question. It was agreed that a weighted mean was probably the most appropriate average to use, where the weights are equal to the inverse of the associated variance:

$$mean(\hat{a}_1, \hat{a}_2, \ldots \hat{a}_n) = \bar{a} = \sum_{i=1}^{n} w_i \hat{a}_i \quad ,$$

where:

$$w_i = \frac{1/var(\hat{a}_i)}{\sum_{j=1}^{n} 1/var(\hat{a}_j)} \quad .$$

The variance of a weighted mean of several abundance estimates is calculated as:

$$var(\bar{a}) = w_1^2 var(\hat{a}_1) + w_2^2 var(\hat{a}_2) + \ldots w_2^2 var(\hat{a}_n) = \sum_{i=1}^{n} w_i^2 var(\hat{a}_i) \quad .$$

Finally, the variance is parameterized as a CV in the provided equation for calculating N_{MIN}. The CV is calculated as:

$$CV(\bar{a}) = \frac{\sqrt{var(\bar{a})}}{\bar{a}}$$

Computation of Average Human-Caused Mortality and its Variance

When estimates of human-caused mortality and serious injury (called here "mortality") are available for more than one year and/or from more than one source, such as a fishery, it is necessary to calculate an estimate of the mean annual mortality along with its associated variance (or CV). The following section provides guidelines for doing this. For convenience, the section refers to averaging the incidental by-catch of fisheries, but the guidelines apply equally well to estimates of human-caused mortality from other sources.

Calculating the overall mean annual by-catch

First, it was agreed that it was most appropriate for the bycatch estimates from a fishery to be averaged UN-WEIGHTED across years, as the true bycatch might be different in each year, and thus is not stationary. This is just the simple average of the available estimates of by-catch. If estimates are available from more than one fishery, a mean annual by-catch from each fishery should be calculated first, and then the annual mean from each fishery should be summed to calculate an overall estimate of the mean annual by-catch.

Calculating the coefficient of variation (CV) of the mean annual by-catch of a single fishery

There are two potential methods for calculating the CV or variance of the mean annual by-catch of a single fishery. Method 1 involves using standard statistical formulas for combining the variances of the individual yearly by-catch estimates (assuming they are available). Method 2 involves estimating the variance empirically from the 2-5 years of point estimates of by-catch, which is done by calculating the standard deviation of the 2-5 mortality estimates and dividing it by the square root of *n*, where *n* is the number of years available. Both methods are valid. However, two points favor Method 1.

First, because the true bycatch might be different in each year, and thus is not stationary, estimating the variance using Method 2 above could over-estimate the true variance of the estimates of bycatch, and this positive bias would be related to how much the bycatch truly varied from year to year independent of observation error.

Second, Method 1 is likely to give a more precise estimate of the variance because it has more degrees of freedom. Using Method 2 involves estimating the variance from a sample size of just 2-5, and ignores the information that is known about the precision of each individual estimate.

Obviously, Method 2 is the only method that can be used if there are no estimates of the variance of the bycatch estimates available. Method 1 is the recommended method if the estimates of by-catch in each year do have an estimated variance (or CV).

Method 1

Table 1 outlines the computations needed for estimates of average by-catch mortality by f fisheries operating over n years. Table 2 gives an example computation for f=3 fisheries operating over a horizon of n=3 years and all of the estimates are non-zero. Most variance estimators will provide an estimate of 0 for the variance when the estimated mortality is zero; however, the true variance is non-zero. In this case, a more realistic estimate of the variance can be developed by averaging the variances for those years which have a positive variance. The variance computations in Table 1 are simply modified by dividing by the square of the number of years with a non-zero variance. The computation of the average is unaffected with the zero included in the average (Table 3). In certain circumstances a fishery may have been operating but was not monitored for mortality. Missing estimates should be dropped both from the calculation of the average and the variance (Table 4).

Method 2

In Method 2 the only change is in how the variance is calculated for the estimate of average by-catch mortality for each fishery over n years. In Method 2 the variance of the average by-catch is estimated empirically from the several point estimates of by-catch available from different years. This is done by calculating the variance of those estimates and dividing it by n, where n is the number of years used in calculating the average:

$$var(\bar{m}_{i.}) = \frac{\sum_{j=1}^{n} \frac{(m_{ij} - \bar{m}_{i.})^2}{n-1}}{n} .$$

The above formula would thus be substituted for the formula for $var(\bar{m}_{1.})$ presented in Table 1. The second step of combining variances across fisheries is identical to Method 1.

Table 1. Computation table for average mortality for n years with f fisheries. The mortality estimate for fishery I during year j is m_{ij} and the corresponding variance estimate is v_{ij}. The estimated total mortality for year j is $m_{.j}$, the sum of mortality estimates for each fishery and the variance is $v_{.j}$, the sum of the variances. The average mortality for fishery I is $\bar{m}_{I.}$ and its variance is $v_{i.}$, which is the sum of the variances for each year within the fishery divided by the number of years (n) squared.

Fishery	Year 1	Year 2 ...	Year n	Average
1	m_{11} var(m_{11})	m_{12} var(m_{12})	m_{1n} var(m_{1n})	$\bar{m}_{1.} = \sum_{j=1}^{n} m_{1j} / n$ $\quad$ $var(\bar{m}_{1.}) = \sum_{j=1}^{n} var(m_{1j}) / n^2$
2	m_{21} var(m_{21})	m_{22} var(m_{22})	m_{2n} var(m_{2n})	$\bar{m}_{2.} = \sum_{j=1}^{n} m_{2j} / n$ $\quad$ $var(\bar{m}_{2.}) = \sum_{j=1}^{n} var(m_{2j}) / n^2$
f	m_{f1} var(m_{f1})	m_{f2} var(m_{f2})	m_{fn} var(m_{fn})	$\bar{m}_{f.} = \sum_{j=1}^{n} m_{fj} / n$ $\quad$ $var(\bar{m}_{f.}) = \sum_{j=1}^{n} var(m_{fj}) / n^2$
Total				$\bar{m}_{..} = \sum_{i=1}^{f} \bar{m}_{i.}$ $\quad$ $var(\bar{m}_{..}) = \sum_{i=1}^{f} var(\bar{m}_{i.})$

Table 2. Example computation of average mortality and its variance for 3 fisheries over 3 years.

		Year			
Fishery		**1**	**2**	**3**	**Average**
1	m	10	3	19	10.67
	v	4	2	8	1.56
2	m	2	13	6	7.00
	v	2	14	4	2.22
3	m	6	33	5	14.67
	v	8	23	4	3.89
Total	m				32.33
	v				7.67

Table 3. Example computation of average mortality and its variance for 3 fisheries over 3 years when some estimates are zero.

		Year			
Fishery		**1**	**2**	**3**	**Average**
1	m	10	0	19	9.67
	v	4	0	8	3.00
2	m	2	13	6	7.00
	v	2	14	4	2.22
3	m	0	0	5	1.67
	v	0	0	4	4.00
Total	m				18.33
	v				9.22

Table 4. Example computation of average mortality and its variance for 3 fisheries over 3 years when some estimates are zero and others are missing.

		Year			
Fishery		**1**	**2**	**3**	**Average**
1	m		0	19	9.50
	v		0	8	8.00
2	m	2		6	4.00
	v	2		4	1.50
3	m	0	0	5	1.67
	v	0	0	4	4.00
Total	m				15.17
	v				13.50

3. Descriptions of U.S. commercial fisheries

Fisheries table in each stock assessment report

Sample incidental fisheries mortality table to be included in stock assessment reports. Each fishery noted as interacting with a stock should be included in the table, even if little information is available. Information on the number of incidental injuries and which injuries should be considered serious should be provided in either the table or the text, if appropriate. See discussion in 5.2 of Wade and Angliss (1997).

Table 5. Summary of incidental mortality of stock ___ due to commercial fisheries from 1990 through 1994 and calculation of the mean annual mortality rate. Mean annual mortality in brackets represents a minimum estimate from logbooks or MMPA reports.

*Note -- numbers indicated with an asterisk are optional -- different preferences have been expressed in different regions.

Fishery Name [1]	Years	Current est. # of vessels	Data Type	Range of Observer Coverage	Observed Mort. (in given yrs.)	Estimated Mort. (in given yrs.)	Mean Annual Mort.
groundfish trawl fishery 1	90-94	490	obs data	53-74%	13, 13, 15, 4, 9	13, 19, 21, 6, 11	14 (0.32)
groundfish trawl fishery 2	90-94	490	obs data	33-55%	2, 0, 0, 1, 1	4, 0, 0, 3, 3	2 (0.24)
longline fishery 1	90-94	1064	obs data	23-55%	1, 0, 0, 1, 0	2, 0, 0, 4, 1	1.4 (0.15)
drift gillnet fishery 1	90-91	509	obs data	4-5%	0, 2	0, 29	14.5 (0.42)
Observer program total							31.9 (0.xx)
set gillnet fishery 1	90-93	120	log book	n/a	0, 1, 1, 1	n/a	[≥.75]*
set gillnet fishery 2	90-93	1187	log book	n/a	0, 0, 0, 2	n/a	[≥.5]*
longline fishery 2	94	213	mmpa reports	n/a	1	n/a	[≥ 1]*
Minimum total annual mortality							≥ 34.2*

[1]The name should be consistent with fishery names in the List of Fisheries.

General information about a fishery (not stock-specific)

Information to provide

As discussed at the GAMMS workshop, information on U.S. commercial fisheries should be included either within each SAR, as an appendix, or as a companion document. Information on U.S. commercial fisheries was collected during the preparation of the Environmental Assessment for the proposed regulations implementing Sec. 118 (NMFS, 1994). The following information, which was provided for each fishery whenever possible, has direct relevance to managing incidental serious injuries and mortalities of marine mammals:

Fishery name: A description of those fisheries that are classified in Category I or II in the LOF, and those fisheries in Category III that have experienced incidental mortality and serious injury of marine mammals should be provided. The Category of the fishery in the List of Fisheries should be specified in the text.

Number of permitholders: NMFS is required by the MMPA to provide the number of permitholders in each fishery included in the List of Fisheries. Information on the number of permitholders in federal fisheries can often be found in recent amendments to Fishery Management Plans. Information on fisheries that occur within state waters but are managed via an interstate commission may be found in interstate fishery management plans. Information on state fisheries that are managed by individual states can typically be found by contacting the state office responsible for licensing commercial fishing vessels.

Number of active permitholders: Because not all licensed commercial fishers participate actively in each fishery, the number of active permitholders may be different than the number of actual permitholders in a fishery. This is particularly true for fisheries that operate in state waters.

Total effort: Provide an estimate of the total fishing effort, in the number of hours fished, for each fishery. This information is typically available only for fisheries that are both federally managed and observed.

Geographic range: Provide a description of the geographic range of the fishery. The description of the geographic range of the fishery should include any major seasonal changes in the distribution of the fishing effort.

Seasons: Describe the seasons during which the fishery operates.

Gear type: Describe the gear type used in the fishery as specifically as possible. Include mesh size, soak duration, trawl type, depth of water typically fished, etc if the information is available.

Regulations: Indicate whether the fishery is managed through regulations issued by the federal government, interstate fishery commissions, individual states, or treaty.

Management type: Indicate what types of fishery management techniques are used to manage the fishery. Some examples include limited entry, seasonal closures, and gear restrictions.

Comments: Include any additional relevant information on the fishery.

Sources of information on U.S. commercial fisheries

The sources of information provided in the Environmental Assessment are listed in the bibliography and on page A21 and A22. In general, good sources of current information on a particular fishery include recent amendments to federal Fishery Management Plans or interstate fishery management plans, and annual reports of Fishery Management Councils or interstate fishery management commissions. Some information may be found on federally managed fisheries in the recent issue of Our Living Oceans (NMFS, 1995). In addition, each Fishery Management Plan has a individual who is the point of contact in the NMFS Regional Offices.

Much information on the geographic ranges of fisheries, seasonal changes in the distribution of effort, etc, was obtained by interviewing key state fishery management personnel. Telephone numbers for Fishery Management Councils, various state Marine Fisheries Commissions, and various state Fish and Wildlife Commissioners can be found in the most recent Conservation Directory published by the National Wildlife Federation (1-800-477-5560; cost per copy is $25.00 + $3.50 shipping and handling, please allow 3-6 weeks for delivery -- OR request a copy of the relevant pages from F/PR2).

4. Recommendations of the GAMMS Workshop

The following recommendations pertaining to the Stock Assessment Reports (SARs) were made by the participants of the Guidelines for Assessing Marine Mammal Stocks (GAMMS) workshop held 3-5 April, 1996. Where appropriate, these recommendations were explicitly incorporated into the current PBR guidelines. Numbers refer to the applicable section of the workshop report.

4.5 Discussion on the definition of stocks

‣ Most of the currently defined stocks are appropriate. Some workshop participants expressed concern about a few particular cases, such as having only one stock of harbor porpoise in Alaska.

‣ For MMPA management purposes, a stock is a management unit that in the best case delineates a demographically isolated biological population. It is recognized that delineated stocks often fall short of that ideal because of a lack of information and for other reasons.

‣ The revised "definition of stocks" section drafted by a working group at the workshop is useful and helps clarify the intent of stock structure decisions, and should be incorporated into the PBR guidelines.

4.7 Incomplete survey of a stock's range

‣ The only way of resolving uncertainty in abundance when a stock's range has not been completely surveyed is to improve the abundance estimate by doing more extensive surveys. Extrapolations of observed densities of animals into areas not surveyed would be useful for survey planning, but should not be used for calculating PBRs. Similarly, it is unacceptable to assume that the point estimate of abundance (rather than the 20th percentile) from the surveyed area can serve as a minimum abundance estimate for the entire stock.

‣ In some cases, because abundance is thought to be under-estimated, it would be useful to calculate the minimum population size necessary to sustain the estimated level of fisheries mortality. This information could optionally be included in the SARs.

‣ Each SAR should include a map showing the area within which the survey took place that led to the estimate of abundance. This map could, if appropriate, also include the survey tracklines, sightings of the stock during the survey, and the distribution of the stock outside the survey area. It was recognized that some abundance methodologies are not dependent upon surveys of the stock's entire range, and therefore this recommendation may not be appropriate in all SARs. For stocks for which transect surveys have not been done, it may be appropriate to include information about the stock's distribution from other sources, such as photo ID locations or other types of sighting information.

5.1 Definition of mortality and serious injury

‣ NMFS should circulate the definition of injury that is included in the regulations. To address this, the following is the regulatory text defining "injury" and "serious injury". Injury is defined

specifically in the C.F.R. (final regulations for implementation of Section 118):

§229.2: "*Injury* means a wound or other physical harm. Signs of injury to a marine mammal include, but are not limited to, visible blood flow, loss of or damage to an appendage or jaw, inability to use one or more appendages, asymmetry in the shape of the body or body position, noticeable swelling or hemorrhage, laceration, puncture or rupture of eyeball, listless appearance or inability to defend itself, inability to swim or dive upon release from fishing gear, or signs of equilibrium imbalance. Any animal that ingests fishing gear, or any animal that is released with fishing gear entangling, trailing, or perforating any part of the body will be considered injured regardless of the absence of any wound or other evidence of an injury."

"*Serious injury* means any injury that will likely result in mortality."

‣ Direct research on the survival of animals injured in fisheries would likely be the best (or even only) way to adequately define the difference between a serious injury (one leading to mortality) and a non-serious injury.

‣ If animals are injured in a fishery, but a determination has not been made as to whether the injuries are serious or not, then estimates of the number of animals injured should be presented in the SARs along with the estimated mortality. This information could be provided in the fisheries table (see below) or within the text of the SAR. Where such an estimate of injury, when added to the estimate of mortality, is responsible for making the sum greater than PBR or 10% of PBR, this should be identified in the SAR.

5.2 Presentation of information about human-caused mortality in the SARs.
‣ A new section should be added to the PBR guidelines which gives guidance about how to present information about annual mortality and serious injury (previously, no guidance was given).

‣ The PBR guidelines should explicitly state that the information in the SARs is expected to include all pertinent information about incidental mortality that will subsequently be used to categorize fisheries in the List of Fisheries.

‣ A table summarizing incidental fisheries mortality and serious injury should be added to the SAR. Where "serious injury" is distinguished from "mortality" in a fishery, both numbers and their sum should be presented. All fisheries that are noted in the List of Fisheries as interacting with each stock should be in the table.
‣ A sample table for reporting information about incidental mortality and serious injury in commercial fisheries should be created and distributed to persons responsible for revising the SARs.

5.3 The description of fisheries in the SARs

‣ Additional information describing the geographical description of fisheries was both of great value and mandated by the MMPA. Where appropriate, an appendix or supplement should be added to the SARs that includes maps showing the location of fisheries with incidental mortality of concern. If possible, the maps should show where the fishery operates (i.e., the estimated distribution of fishing effort). If the exact location of fishing effort is not known, a rough indication of fishing areas and ports used by the fishery would be useful. For observed fisheries, it would also be useful to have a map indicating where fishing activities were observed, and the location of observed marine mammal mortalities and injuries.

‣ It was recommended that the NMFS Office of Protected Resources circulate a list of what fishery information would be useful to include, and to provide the text of the Environmental Assessment if it would be helpful to those collecting fishery information.

6.0 Habitat issues

‣ A statement about habitat issues should be included in the Status section of the SARs, or, if needed, in a separate section titled "Habitat issues". If data exist that indicate a problem, they should be summarized and included in the SARs. If there are no known habitat issues for a stock, that this should be explicitly stated, as consideration of habitat issues are mandated by the act.

8.0 Calculation of PBRs

‣ The current PBR guidelines on calculating PBR are adequate and sufficient in most areas. It is recommended that minor changes to some sections of the guidelines be made. These changes are covered in the sections below.

8.1 Time period from which to use data on abundance and mortality

‣ Confidence in the reliability of an abundance estimate declines with age. Therefore, estimates older that 8 years should not be used to calculate PBR. This is necessary to meet the requirement in the MMPA that Nmin represent a level for which there is reasonable assurance that the true population is larger. The consequence of not being able to calculate a PBR for such stocks is that PBR is unknown (not that PBR equals zero). A decision as to whether such stocks are strategic or not will be jointly decided case-by-case by NMFS or FWS and by the SRGs. This recommendation replaces the guidelines stating that recovery factors were "ratcheted down" as abundance estimates became older than 5 yrs.

‣ An unweighted mean should be used when averaging mortality over more than one year.

‣ A section giving guidance on what mortality estimates to use was drafted and added to the revised PBR guidelines.

8.2 Combining estimates and Calculating CV of a product

‣ A new section was drafted to be added as a technical supplement to the PBR guidelines.

8.3 Problems associated with species which are difficult to identify

‣ The collection of biopsy samples and voucher material is strongly encouraged, particularly for species without such materials and other hard to identify species. In particular, voucher material is needed for these species of *Mesoplodon* beaked whales: *M. carlhubbsi, M. ginkodens, M. densirostris, M. hectori, M. europaeus, M. mirus*.

‣ National experts should be encouraged to revise a field guide to the identification of beaked whales and *Kogia* spp.

8.5 Changing recovery factors from default values (particularly endangered whales)
‣ Clarification should be added to the guidelines that flexibility exists to change default recovery factors (such as for endangered species) on a case-by-case basis with careful consideration of the information available for each stock. Such changes should be made in consultation with, and when appropriate should reflect the recommendations made by, the NMFS or FWS center(s) and region(s) responsible for the SARs and the relevant Scientific Review Group. Such changes should be justified by credible scientific evidence. It was acknowledged that this was a complex and difficult issue; therefore the evidence used to support any change to the recovery factor of an endangered species should be carefully documented in the SAR.

8.7 Correction factors for pinniped counts.
‣ Caution should be used when considering the application of correction factors for abundance estimates to stocks in other locations, or to other species. Additionally, caution should be used in applying correction factors in different situations in the same location (e.g., tidal state, season, time of day, etc.). The use of estimated correction factors without associated variance estimates is to be avoided. Where the use of such a correction factor is considered unavoidable, it is suggested that a default CV should be used that is greater than the 0.0 currently assumed for several stocks.

9.1 Review and Revision
‣ A section would be added to the PBR guidelines to describe the annual review, revision, and publication of the SARs.

‣ The review process leading to revision recommendations should be a joint consultation between the appropriate NMFS personnel (at both Centers and Regions) and the SRGs.

‣ The SARs should be revised whenever new information becomes available on abundance, mortality, R_{max}, or stock structure. It is best to revise the SARs whenever new information is available, even if the new information does not affect whether the stock is strategic. Although it is anticipated that new estimates of mortality from a fishery observed for several years will often not change the classification of a stock, NMFS and FWS should still be encouraged to publish a revised SAR even if the only new information is a new estimate of mortality, in the interest of keeping the SARs as up to date as possible.

9.2 Annual schedule for revising and publishing the SARs

‣ A target annual time line for the stock assessment process was agreed upon. It was agreed that in 1996, NMFS will attempt to meet a deadline of October 1 for completing draft revisions of SARs and making these draft SARs available for public comment.

9.3 Publication issues

‣ The majority of the workshop participants agreed that all of the SARs should be published every year. It was recognized as unfortunate that a certain amount of duplication and perhaps unnecessary waste of paper would take place, but any other scheme was thought to be potentially confusing. It was further noted that new estimates of mortality would likely be available every year for a large percentage of the stocks, and thus it will likely be good practice to revise the SARs for those stocks. Finally, it was agreed that keeping the SARs as up to date as possible would best serve NMFS and FWS constituents. It was also recommended that a last date of revision be printed at the top of the first page of each SAR, so it would be clear when each was last revised.

‣ NMFS and FWS should attempt to maintain the same schedule for reviewing, revising, and publishing the SARs, and if possible, publish the SARs in joint regional documents.

9.4 Suggested forum for abundance and mortality estimate manuscripts

‣ The methods and analyses that produce the estimates of abundance and mortality that are used in the SARs should be published in peer-reviewed scientific journals, where possible, or in a similar forum that is most appropriate, such as a NOAA Technical Memorandum.

10.0 List of Fisheries (Section 118)

‣ It is useful and important to include as much relevant information as possible about fisheries in the SARs. For fisheries without observer programs, information about the number of vessels, method of fishing, and area of operation are all important considerations in categorizing these fisheries. It would be beneficial to have this information documented in the SARs so that it would be subject to review by the centers, regions, and SRGs, as well as be readily available when the SARs are finalized. Therefore, it was concluded that the SARs should document all important information used to categorize fisheries in the List of Fisheries.

‣ It was recognized that, ideally, the List of Fisheries would be based on the incidental mortality information included in the SARs. However, if new sources of information become available that are not included in the SARs, this information may also be used.