U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments

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This report documents the guidelines that were used for preparing the U.S. marine mammal stock assessments that are required by the 1994 ammendments to the Marine Mammal Protection Act, as well as the report of the workshop that led to the first draft of the guidelines. Additionally, this report summarizes the results of the 1995 assessments, the first year that assessments were prepared.

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Introduction

The new section 117 (amended in 1994) of the Marine Mammal Protection Act (MMPA) requires the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) to prepare, in consultation with regional Scientific Review Groups, draft assessment reports for each stock of marine mammal that occurs in waters under U.S. jurisdiction. The agencies are to make these reports available for public review and comment and prepare final stock assessment reports based upon public comments and continued consultation with the Scientific Review Groups. This report contains the guidelines that the agencies used to prepare the 1995 stock assessments, along with additional background that went into the preparation of the guidelines and the stock asssessments. Additionally, the results of the final 1995 stock assesssments are summarized.

The 1994 Amendments to the MMPA require that each stock assessment report contain several items, including (1) a description of the stock, including its geographic range; (2) a minimum population estimate, a maximum net productivity rate, and a description of current population trend, including a description of the information upon which these are based; (3) an estimate of the annual human-caused mortality and serious injury of the stock and, for a strategic stock, other factors that may be causing a decline or impeding recovery of the stock, including effects on marine mammal habitat and prey; (4) a description of the commercial fisheries that interact with the stock, including the estimated level of incidental mortality and serious injury of the stock by each fishery on an annual basis; (5) a statement categorizing the stock as strategic or not, and why; and (6) an estimate of the potential biological removal level (PBR) for the stock, describing the information used to calculate it.

The primary goal of the MMPA is to ensure that each stock of marine mammal does not have a level of human-caused mortality and serious injury that is likely to cause the stock to be reduced below its optimum sustainable population level. A marine mammal stock is designated as strategic if (A) its level of direct human-caused mortality exceeds the potential biological removal level; or (B) it is listed as a threatened or endangered species under the Endangered Species Act of 1973 (16 U.S.C. et seq.), or is designated as depleted under the MMPA; or (C) it is declining and is likely to be listed as a threatened species under the Endangered Species Act of 1973 within the foreseeable future.

Part I of this report provides background information on how the draft reports were prepared (p. 4-26). Although the MMPA specifies the three components of a PBR (i.e., a minimum population estimate, one-half the maximum net recruitment rate, and a recovery factor), it does not define them specifically in quantitative terms. Therefore, to prepare initial draft guidelines for calculating PBR and for writing the draft stock assessment reports, NMFS and FWS convened a PBR workshop, which was held June 27-29, 1994, in La Jolla, California. The report of that workshop is included here as Part I. In addition to providing specific advice for preparing the draft assessment reports, the opening chapter contains a review of the directions provided in the MMPA, the need for more specific instructions for ensuring consistency in preparing reports, and the guiding principles for making decisions needed for the draft stock assessment reports.

A brief summary of the simulation analyses that were used at the PBR workshop to choose a specific percentile for calculating N_{min}, as well as for choosing a value for the recovery factor, is given in Part II (p. 27-30). These analyses are described in full in Wade (1994), which followed the initial methods of Taylor (1993), who loosely based her methods on the simulation trial approach used by the International Whaling Commission to select a Revised Management Procedure. A modification to the value used for the recovery factor for cetacean stocks of unknown status was made subsequent to Wade (1994), and the basis for that modification is explained here.

Immediately after the PBR workshop, the specific advice agreed upon at the workshop was extracted as a set of draft PBR guidelines. The guidelines also specified a format for writing the stock assessment reports (SARs), as well as providing guidance on other issues, such as how to define stocks. These guidelines were used for preparing the draft SARs of August 1994. The guidelines have since been continually modified over the course of the year in response to comments from the regional Scientific Review Groups, the public (including interest groups), the Marine Mammal Commission, and from NMFS scientists from the Centers and Regions, particularly authors of the SARs and members of the MMPA implementation task force. Part III (p. 31-38) of this report contains the revised PBR guidelines that were used for preparing the final 1995 stock assessment reports.

Part IV (p. 39-56) of this report provides a summary of the results of the 1995 final stock assessment reports. It includes the full PBR table published in the Federal Register which contain the estimated PBR (as well as its elements) and human-caused mortality for all 145 stocks of marine mammals in U.S. waters under NMFS jurisdiction. It also contains lists of strategic stocks by region, and a list of stock specific estimates of mortality in fisheries which have substantial interaction with stocks which have incidental mortality greater than their PBR.

The 1994 amendments to the MMPA also provided for the formation of three regional Scientific Review Groups (Atlantic, Pacific, Alaska). NMFS and FWS staff discussed the guidelines for the draft assessment reports with the Scientific Review Groups at a series of meetings. The first meeting, convened in Seattle, Washington, October 12-13, 1994, brought all three review groups together to examine and discuss the guidelines, and to allow the review groups to provide their initial recommendations regarding the guidelines. Subsequent meetings between agency staff and the review groups produced additional recommendations on the guidelines and on individual assessment reports. The reports of the combined meeting are included as appendices in this report.

This report is one of a series of four produced by NMFS. The other three reports contain the final stock assessment reports prepared by NMFS for the three regions covered by Scientific

Review Groups: Alaska including the North Pacific (Small and DeMaster 1995), the Atlantic coast including the Gulf of Mexico (Blaylock et. al. 1995), and the Pacific coast including Hawaii (Barlow et. al. 1995).

References

Barlow, J., R. L. Brownell, Jr., D. P. DeMaster, K. A. Forney, M. S. Lowry, S. Osmek, T. J. Ragen, R. R. Reeves, and R. J. Small. 1995. U.S. Pacific Marine Mammal Stock Assessments. NOAA Tech. Memo. NMFS-SWFSC-219, 162 pp.

Blaylock, R. A., J. W. Hain, L. J. Hansen, D. L. Palka, and G. T. Waring. 1995. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments. NOAA Tech. Memo. NMFS-SEFSC-363, 211 pp.

Small, R. J. and D. P. DeMaster. 1995. Alaska Marine Mammal Stock Assessments. NOAA Tech. Memo. NMFS-AFSC-57, 93 pp.

Part I. Report of the PBR (Potential Biological Removal) Workshop, June 27-29 1994, Southwest Fisheries Science Center, La Jolla, California

Workshop Background and Purposes

The 1994 amendments to the Marine Mammal Protection Act (MMPA) require the National Marine Fisheries Service (NMFS) and the Fish and Wildlife Service (FWS) to complete stock assessment reports for all marine mammal stocks within U.S. waters by August 1, 1994. These stock assessments must include information on how stocks were defined, a calculation of Potential Biological Removals (PBRs), and an assessment of whether incidental fishery takes are "insignificant and approaching zero mortality and serious injury rate". Because the amendments provided only limited guidance and because there is a clear need to establish, where possible and appropriate, quantitative criteria that may be consistently applied to marine mammal stocks between Regions for developing the stock assessment reports, the NMFS convened a workshop with the FWS to review and come to agreement on these issues. The workshop was held at the Scripps Institution of Oceanography, La Jolla, California on 27-29 June 1994. The workshop agenda, terms of reference, list of participants, and list of reference documents are attached as appendices to this report.

MMPA Goals and Objectives

The primary goal of the MMPA is to maintain the health and stability of marine ecosystems. Three explicit goals related to this are to maintain stocks at Optimum Sustainable Population (OSP)[1] levels and as functioning elements of their ecosystems, to restore depleted stocks to OSP levels, and to reduce incidental mortality and serious injury to "insignificant levels approaching a zero mortality and serious injury rate". The legislative record of this Act frequently refers to another, implicit goal which is to minimize interference with commercial fishing enterprises while meeting the other goals. In order to measure the quantitative performance of any proposal to meet these goals, it is necessary to quantify what is meant by them. In this regard, the workshop participants agreed on the following interpretations:

Goal 1: Maintain OSP and Ecosystem Function

The workshop participants interpreted the goals of maintaining stocks within OSP levels and of maintaining stocks as functioning elements of their ecosystems as being met if, when the

[1]The Marine Mammal Protection Act defines the term "optimum sustainable population" to mean, "with respect to any population stock, the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element." For operational purposes, the National Marine Fisheries Service and the Fish and Wildlife Service have interpreted this definition to mean "a population size which falls within a range from the population level of a given species or stock which is the largest supportable within the ecosystem to the population level that results in maximum net productivity (MNP)." Maximum net productivity is defined as "the greatest net annual increment in population numbers or biomass resulting from additions to the population due to reproduction and/or growth less losses due to natural mortality" (50 C.F.R. § 216.3).

estimated PBR is removed each year, stocks will equilibrate within OSP at least 95% of the time, assuming reasonable levels of imprecision in estimating population size, take levels, and population growth rates.

Goal 2: Restore Depleted Stocks to OSP

For stocks that are endangered, threatened or depleted or for stocks of unknown status and which are not known to be increasing in the presence of human-induced mortality, an additional level of protection should be applied to ensure recovery to OSP. The workshop participants believed that this additional protection should allow stocks to equilibrate within OSP levels at least 95% of the time while taking into account probable ranges of imprecision and error (bias) in measuring population size, take levels, and population growth rates. If a stock is endangered or threatened, PBR levels should be negligible, and in no case should incidental take levels delay recovery of endangered species by more than 10% of the estimated recovery time in the absence of any incidental take.

Goal 3: Zero Mortality Rate Goal

The workshop participants interpreted this goal to be met by reducing incidental mortality from commercial fishing operations to levels significantly below PBR levels so that the incidental mortality has a negligible effect on the status of the affected stock, and for stocks listed as endangered or threatened under the Endangered Species Act, to levels such that the time required for those stocks to recover to OSP is not significantly increased.

Goal 4: Minimize Unnecessary Interference with Commercial Fisheries

The workshop participants interpreted this goal to mean that limits on allowable removals (i.e., incidental mortality and serious injury) should not be unnecessarily conservative and/or restrictive of commercial fishing operations, while remaining consistent with the stated goals of the MMPA.

Principles of Conserving Wild Living Resources

The goals of the MMPA embody several principles that have been developed to promote better conservation of wild living resources (Holt and Talbot, PBR/1). These principles include:

> (1) The ecosystem should be maintained in a desirable state such that consumptive and non-consumptive values are maximized [optimized] on a continuing basis, present and future options are ensured, and risk of irreversible change or long-term adverse effects as a result of use is minimized;

(2) Management decisions should include a safety factor to allow for the fact that knowledge and institutions are imperfect;

(3) Measures to conserve a wild living resource should be formulated and applied so as to avoid wasteful use of other resources; and,

(4) Survey or monitoring, analysis, and assessments should precede planned use and accompany actual use of wild living resources.

Since these original principles were first formulated by Holt and Talbot (PBR/1), several additional factors have been recognized that are giving rise to new principles (M. Mangel, pers. comm.). Of these new principles, it is relevant to note:

(1) There is an increasing realization that population dynamics are stochastic, rather than deterministic, and that the results of resource use cannot be reliably predicted even with perfect information [This emphasizes the need for continued monitoring to accompany resource use.];

(2) Optimizing the value of resources requires that the full range of values be considered including, scientific, aesthetic, and socio-economic values. [The incorporation of a variety of different value systems requires the involvement of all affected parties in the management process, and therefore management should be made as transparent as possible]; and,

(3) In the present world, we are frequently dealing with populations that are already depleted and habitats that are severely degraded, and therefore, recovery may be required before intelligent use of resources can be accomplished.

PBR Elements

The 1994 amendments to the MMPA state that, as part of the stock assessment reports, NMFS must develop estimates of Potential Biological Removals (PBRs) for each marine mammal stock in U.S. waters. The term 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". PBRs are to be calculated as the product of three elements: (1) the minimum population estimate (N_{min}); half the maximum net productivity rate ($0.5\ R_{max}$); and a recovery factor (F_r). It was the workshop participant's principal objective to identify criteria for defining input values for these elements that would serve as a nationwide standard for calculating PBRs.

N_{min} is defined in the 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."

One-half R_{max} is defined 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." F_r was defined as a factor whose value would range from 1.0 to 0.1.

The workshop participants concluded that the three PBR parameters must be evaluated together, rather than independently, in the context of meeting the goals of the MMPA. For example, if recovery factors are very conservative, the definition of N_{min} can be less so and still provide an appropriately conservative estimate of PBR. It was the sense of the workshop participants that values for N_{min} could be estimated that would result in stocks reaching their OSP, default or empirically based estimates for one-half R_{max} could be identified, and F_r should serve to weight the PBRs so as to take into account uncertainty in those estimates. In this sense F_r was considered a 'safety factor' that would allow the taking of individuals from stocks below OSP while continuing to promote their recovery and that would provide a safety margin to account for unknown bias in stock status information (e.g., estimation of abundance, productivity, mortality) and for stocks of unknown status or trends.

Finally, some of the participants commented that distinct advantages of the PBR approach included that it was not based on any particular population model, it allows conservative management to proceed when lacking detailed information, it provides an incentive to improve information on stock size (e.g. to lower CVs), it is based on readily measurable quantities, and it focuses on achievable goals. They noted, however, that although the approach is not tied to a particular population model, once specific values for input parameters for the three elements were identified, their performance should be evaluated using simulations with a variety of population models.

Minimum Population Estimate (N_{min})

For N_{min} the workshop agreed to use 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), calculated as:

$$N_{min} = N/\exp(z\ (\ln(1+CV(N)^2))^{½}) \qquad (1)$$

where N is the abundance estimate, CV(N) is the coefficient of variation of the abundance estimate, and z=0.842 (Wade, PBR/5). In cases where a direct count was available, such as for many pinniped stocks, this direct count (corrected when possible to include a minimum estimate of the animals not counted) could alternatively be used as the estimate of N_{min}. Such a corrected count can be used as the estimate for N_{min} provided that a variance for that estimate is available, in which case N_{min} is the lower 60th percentile of the appropriate statistical confidence interval.

The need for frequently updating abundance estimates was emphasized both as a means for ensuring current estimates of PBR and as a method for detecting failures of the PBR approach. It was agreed that calculated PBR values should be decreased by 20% per year when minimum population estimates are more than 5 years old. If abundance estimates are not updated, PBRs would therefore decrease to zero at 10 years after the last abundance estimate.

N_{min} is, as noted earlier, defined 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 a reasonable assurance that the stock size is equal to or greater than the estimate." This indicates that a value less than a "best" or mean estimate is intended. Clearly, a lower confidence limit meets this criterion and would incorporate the precision and variability of the estimate. Not specified in the Act is specifically what percentile provides a reasonable assurance that the population is equal to or greater than that estimate.

The original NMFS proposal suggested using a lower 95% confidence limit (the 2.5th percentile). Taylor (PBR/3) presented simulation studies that indicated that the 2.5th percentile, in combination with an F_r of 0.5, was lower than necessary to allow stocks to recover to or remain within OSP, even in the presence of substantial, but plausible, bias in the abundance and mortality estimates, or in the default value used for one-half R_{max}.

The workshop participants agreed that the criteria for judging the performance of a specific percentile should be:

(1) A stock of unknown status would be maintained within OSP with 95% probability.

(2) A stock starting at the lower bound of OSP (i.e., 0.6K) would still be within OSP after 20 years with 95% probability.

The workshop participants concluded that simulation trials such as those employed by Taylor (PBR/3) could be used to judge the performance of other methods for specifying a value for N_{min}, as long as such a method incorporated the precision of both the abundance and mortality estimates. They also agreed that N_{min} should be chosen assuming that there were no substantial biases or problems in the available data, but that conservatism be built into the value of F_r to address these issues. Thus, the simulation trials to judge the performance of various percentiles were performed with F_r set to 1.0.

Lerczak et al. (PBR/4) used simulation trials to set N_{min} to the fraction of the mean estimate (50th percentile), that, as a function of the coefficient of variation of the abundance ($CV_{(N)}$) and mortality ($CV_{(M)}$) estimates, and the assumed value for one-half R_{max}, would result in 95% of the stock trajectories being within OSP after 100 years. This method results in a unique percentile being specified for every combination of ($CV_{(N)}$) and ($CV_{(M)}$), and one-half R_{max}.

Wade (PBR/5) used the same performance criteria to find the single percentile that would meet this goal for a plausible range of combinations of values for $CV_{(N)}$ (i.e., 0.2 and 0.8), $CV_{(M)}$ (i.e., 0.3), and one-half R_{max} (i.e., 0.02 and 0.06). His results indicated that the 20th percentile of a log-normal distribution was sufficient to allow all performed trials to meet or exceed the performance criteria.

There was substantial discussion about whether it would be best to select a single percentile that met the above performance goals in all cases (the Wade proposal), or whether the percentile should be selected on a case-by-case basis (the Lerczak et al. proposal). The choice of a single percentile to be used in all cases was thought by some to meet the stated definition that N_{min} provide a reasonable assurance that the stock size is equal to or greater than the estimate. However, others pointed out that setting the percentile to a value that met the performance criteria for all cases would lead to being unnecessarily conservative in some cases. The workshop participants agreed that for this report, the 20th percentile would be recommended for use as the estimate of N_{min}.

Use of a lower confidence limit that is dependent upon the estimated $CV_{(N)}$ has the desirable property of encouraging improvement in abundance estimation techniques, as more precise estimates of abundance will lead to higher and less variable PBR levels. Improvement of abundance estimates could, in some cases, improve the estimate of the appropriate PBR level such that neither fisheries nor other sources of mortality and injury exceed that level (individually or collectively).

Maximum Rate of Increase (R_{max})

The workshop participants proposed that default values be used for R_{max} in the absence of stock-specific measured values. These default values should be 0.12 for pinnipeds and sea otters and 0.04 for cetaceans and manatees. The default value for pinnipeds and otters was selected by conservatively choosing the lower end of the range of measured maximum growth rates for these taxa: 12% to 18% per year. The default value for cetaceans is based on theoretical calculations that show that dolphin populations can not grow at rates much greater than 4% given the constraints of their reproductive life history (Reilly and Barlow 1986). Whales and manatees were included with dolphins based on similarities in their life history characteristics. These default values are believed to be within a reasonable range of values for these species, but this crude classification is not meant to suggest that the growth potential of all species and stocks within these groups are equal. Much lower values (smaller than half the default values) should not be considered unreasonable. Management guidelines should therefore be sufficiently robust that they still achieve the MMPA goals when actual values are lower than the defaults.

When reasonably reliable stock-specific information is available on R_{max}, it is anticipated that this would replace the default values. To ensure that stock-specific information is sufficiently reliable, the workshop participants proposed that a statistical test be used to determine whether the measured value is significantly different from the default value. Because the potential harm caused to a stock by changing to an R_{max} value that is too high is greater than the potential harm caused by changing to a value that is too small, we propose that alpha levels for statistical comparisons be 0.05 for changing to a higher R_{max} and 0.20 for changing to a lower R_{max}. In the absence of a statistical test, other reliable information bearing on R_{max} could be used to decrease (but not increase) from a default value. Evidence for changing R_{max} from a default value should be based on data that include the entirety of a closed population to minimize unknown biases. Evidence to support an increase from a default value can be based on a measured growth rate that is greater than the default value. Evidence to support a decrease from a default value must be based on an empirically measured growth rate of a population that is depleted and, therefore, can be assumed to be growing at its maximum rate. Because of the extreme difficulty in gathering such data for cetaceans, we anticipate that default values will be used for the vast majority of cetacean stocks for the foreseeable future.

Recovery Factor (F_r)

The workshop participants agreed that the recovery factor (F_r) for endangered species and stocks should be 0.1 and that the recovery factor for depleted and threatened stocks and stocks of unknown status should be 0.50 for pinnipeds and 0.65 for cetaceans. They also agreed that stocks known to be within OSP or known to be increasing in the presence of takes greater than the calculated PBR could have higher values, up to and including 1.0.

Although the 1994 amendments of the MMPA provide no specific guidance for setting the values of F_r, they state that a recovery factor of between 0.1 and 1.0 be specified for each stock. The original NMFS proposal suggested using arbitrary F_r values of 0.1 for stocks listed as endangered, 0.5 for stocks of unknown status or listed as threatened or depleted, and 1.0 for stocks thought to be within OSP.

The intent of the recovery factor was felt to be that it should compensate for uncertainty and possible unknown estimation errors, and that it accommodate additional information and allow for management discretion as appropriate and consistent with the goals of the MMPA. The workshop participants agreed that different values for F_r were appropriate for the categories of: (1) stocks listed as endangered; (2) stocks listed as threatened, depleted, or of unknown status, and (3) stocks thought to be within OSP. They also agreed that the recovery factor for stocks of unknown status should provide sufficient robustness for the PBR management scheme such that there would be a high degree of assurance that stocks remained at or recovered to OSP even under conditions of serious but plausible errors in the available information.

The workshop participants agreed that the robustness trials of Taylor (PBR/3) provided a framework for testing whether specific values for F_r resulted in a reasonable assurance that stocks of unknown status would recover to or be maintained within OSP. Therefore, they agreed the F_r be selected for stocks of unknown status such that:

> (1) Any marine mammal stock would be maintained within OSP with at least 95% probability under "robustness trials" which represented plausible bias in abundance estimates, mortality estimates, and in the specification of values for one-half R_{max}, and,
>
> (2) Any marine mammal stock starting at the lower bound of OSP (i.e., 0.6K) would still be within OSP after 20 years with 95% probability. Wade (PBR/5) demonstrated that, when using the 20th percentile for N_{min}, the values of 0.50 for pinnipeds and 0.65 for cetaceans met or exceeded the performance criteria.

A more conservative value for pinnipeds was necessary to allow the robustness trials to meet the performance criteria because their higher default value for one-half R_{max} allows a greater magnitude of excessive incidental mortality when information is biased.

Stocks known to be within OSP and stocks of unknown status that are known to be increasing in the presence of human takes could have their F_r set to values as high as 1.0. However, it was suggested that before such action is taken, reasonable scientific justification should be provided that the estimates of abundance and mortality are not severely biased and have estimated CVs less than or equal to 0.8 for the abundance estimate and 0.3 for the mortality estimates.

In its legislative proposal for governing interactions between marine mammals and commercial fishing operations, NMFS suggested that 90% of the annual net production of a stock of endangered species of marine mammals should be reserved for recovery of the stock and only 10% of net production should be authorized for removal due to human causes (e.g., incidental takes in commercial fisheries). This large portion of the net production was allocated to growth to allow stocks to recover at near maximum rates, and to minimize the probability that naturally occurring stochastic mortality would result in extinction of the stock.

The workshop participants believed that authorized levels of human-related mortality should increase recovery time of endangered stocks by no more than 10% (consistent with the goal stated in the NMFS legislative proposal). Therefore, a value for F_r of 0.1 was chosen for endangered stocks of marine mammals. Wade's simulations (PBR/5, Fig. 11) supported the use of 0.1 as an appropriately conservative value for F_r that would ensure no more than a 10% increase in recovery time with the chosen value of N_{min} (i.e., the lower 20th percentile) with a $CV_{(N)}$ in the range 0.2-0.8.

Mortality Rate

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 be reduced to insignificant levels approaching zero mortality and serious injury rate. The Amendments require that stock assessment reports describe fisheries that interact with (i.e., kill or seriously injure) marine mammals. These descriptions must contain "an analysis stating whether such level is insignificant and is approaching a zero mortality and serious injury rate." The amendments also state that all commercial fisheries must reduce incidental mortality and serious injury of marine mammals to insignificant levels approaching zero mortality rates within 7 years of enactment of the 1994 amendments. This will be referred to as the "zero mortality rate goal" (ZMRG).

Neither the 1994 amendments nor any other part of the MMPA (including the legislative history) provide clear guidance concerning the meaning of "insignificant levels approaching zero mortality and serious injury rate". The legislative history suggests, however, that some level of marine mammal mortality and serious injury may occur at insignificant levels (i.e., the requirement is not zero mortality).

The workshop participants agreed that "insignificant" levels must be relative to the biological significance of incidental mortality. Biological significance is measured in terms of the impact such mortality has on the affected stock of marine mammals. An insignificant level of mortality is a level that has a negligible impact on the affected stock.

Criteria for Measuring Insignificant Levels

The workshop participants agreed that mortality and serious injury incidental to fishing operations would be insignificant to a stock of marine mammals if such mortality and injury were only a small portion (e.g., 10% of the PBR) of the affected stock. When total fishery take (incidental mortality and serious injury from all fishing operations combined) is such a small portion, then fisheries would be a negligible mortality factor for the affected stock of marine mammals (i.e., all fisheries that take the affected stock would have reached insignificant levels approaching a zero mortality and serious injury rate for that stock of marine mammals). If, however, total fishery mortality for the affected stock is greater (e.g., more than 10% of PBR), then mortality and serious injury incidental to fishing operations could not be considered insignificant.

The workshop participants concluded that a fishery-by-fishery analysis for "insignificant levels approaching zero" was beyond the scope of preliminary stock assessment reports. Such an analysis would need to consider disparate measures of fishing effort, the value and yield of the interacting fisheries, and possibly other variables. Thus deciding what constitutes achieving the Act's ZMRG for a particular fishery is a management, rather than a scientific, decision.

Definition of "Stock"

At the species level, taxonomy in the stock assessment reports should be consistent with Wilson and Reeder (1993) or more recent work. Below this level, the population "stock" is the fundamental unit of legally mandated conservation efforts. In practice its determination is often a problematic, but nevertheless essential, exercise. The MMPA provided both biological and ecological guidance for making such determinations. The biological guidance is in the definition of population stock: a group of animals in common spatial arrangement that interbreeds. The ecological guidance is addressed in the requirement that a stock be maintained as a functioning element of the ecosystem. The clear intent of the MMPA is to restore and maintain stocks within their OSP. Therefore, a risk-averse strategy of defining the stocks should be used to be consistent with these goals.

General Guidelines

A risk-averse strategy requires starting with a definition of stocks based on small groupings that are only "lumped" when there is compelling evidence to do so. Such evidence comes from biological studies. However, in the event of virtually no biological stock data, a stock should be defined simply as the area from which marine mammals are taken (i.e., the area in which the fishery is operating). This is commonly encountered when a fishery takes animals from a small portion of their entire range. The whole range is not considered the stock because the degree of intraspecific exchange is unknown. Taylor (PBR/10) showed that populations can be depleted under the PBR scheme if subpopulations with low mixing (< 2% per year) are mistakenly managed as a single unit. When mixing rates are uncertain, risk-adverse management will therefore require assessment of whether the stock differentiation technique has sufficient power to detect the population structure relevant to the PBR management scheme. The assumption is that large panmictic populations are rare. To define a small area management unit does not require statistical evidence of stock differentiation. In general, in the absence of data, this is likely the most effective conservation strategy.

However, there are situations where this is not the case. An example of this is a stock that experiences mortalities in one fishery in one season and migrates to another area where it experiences mortality in another fishery.

Problems occur in choosing and evaluating evidence of population sub-division. In our risk-averse procedure the situation is reversed; however, the principles remain the same. Data are evaluated in an ecological and evolutionary context to ensure that biologically meaningful units are constructed (evolutionarily significant units, ESUs). An example of a failure of this would be to erect management units based on family groupings or recent, anthropogenically isolated populations. Waples (PBR/9) and Dizon et al. (PBR/7, PBR/13) provide guidelines based on evaluation of ecological data (e.g. habitat, distribution, movements), life-history data, morphological data, and the genetics of neutral genes. In the risk-averse approach, negative evidence (evidence for a lack of difference) is used to coalesce smaller units into larger ones. As a result, an appreciation of the relative statistical power of the data being evaluated is required. A demonstration of sufficient statistical power is required before a recommendation of larger stock units is accepted.

Specific Criteria for Stocks

(1) Stocks should be initially defined based on the smallest divisible unit approaching that of the area of take unless there exists evidence of smaller subdivisions. Such evidence may come from ecology, life-history, morphology, and the genetics of neutral genes.

(2) Stocks can be coalesced from this level using evidence from the above sources providing some idea of statistical power of such tests are available.

(3) In trans-boundary situations where a stock's range spans international boundaries or EEZ/pelagic boundaries, it is recommended that, if a stock is migratory, the fraction of time in U.S. waters should be noted and the PBR based on the total stock. In a non-migratory situation, the fraction of the stock in U.S. waters should be estimated. The PBR and mortality should be calculated on the total stock if possible. If the estimate is available for U.S. waters only, that should be noted and the PBR and mortality calculated based on the estimate of the stock residing in U.S. waters. In addition, efforts should be made to initiate cooperative research and management programs with the involved nations in whose waters the remainder of the stock resides.

(4) For situations where a large pelagic stock experiences coastal mortalities, PBR calculations should be based on the area of the coastal take unless there is evidence for coalescing the stock based on #2.

(5) Stock Assessment Reports must be made for all stocks that occur in U.S. waters. The workshop participants assumed that Stock Assessment 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).

Summary and Conclusions

Draft Criteria

Through its deliberations the workshop participants developed draft criteria for defining the elements for calculating PBRs (i.e., minimum population size, one-half the maximum rate of increase, and the recovery factor), criteria for stock identification, and criteria for evaluating progress towards the "zero mortality rate goal". This report will be submitted along with the draft stock assessment reports and, as such, the draft criteria shall be subject to review and comment along with the stock assessment reports.

Continued Monitoring

Participants also noted that monitoring of population size, distribution, and productivity will be required to verify the effectiveness of the PBR approach to management. This is particularly true in cases of uncertainty concerning population discreteness, size and productivity, the total level of human-caused mortality, and the status of essential habitat or prey species. However, even with perfect information, the response of populations cannot be reliably predicted, and some level of continued monitoring will be required for all stocks to ensure that the PBR approach is working as intended.

Future Research Needs

Throughout their discussions, the workshop participants identified numerous opportunities for continuing or additional research that would advance and assess the performance of the PBR scheme. In this regard, they identified the following research areas:

(1) Develop realistic basis for the robustness trials: The robustness trials that have been used in the Taylor (PBR/3), Lerczak et al. (PBR/4) and Wade (PBR/5) analyses are hypothetical scenarios and are applied individually. Examples based on case histories from each region could provide a more realistic set of scenarios and indicate some multiple interactions. An example is a highly aggregated stock in which both the abundance estimate and the kill estimate could be significantly affected by a few large samples.

(2) Ancillary PBR information: There is a need to develop methods for calculating a PBR that include other abundance information besides the most recent abundance estimate. Factors to consider are history of abundance and catch estimates similar to the IWC approach and information on immigration and emigration from tagging or tracking experiments.

(3) Review pinniped R_{max} information: A review is needed of the information available on R_{max} for pinnipeds, similar to the work of Reilly and Barlow (1986) for delphinids and Best (1993) for baleen whales.

(4) PBR input parameters: There is a need to develop an approach for using ancillary information (parameter values and estimates of their precision) that would allow an adjustment of the recovery factor or R_{max} on specific stocks. The actual adjustment would be made on a stock-by-stock basis. This exercise would provide a shopping list of potential issues and rank them according to importance.

(5) Alternative population models: The performance of the PBR proposal should be tested using a variety of different population models (e.g., models that account for age and sex structure, variation in recruitment, variation in K, spatial distribution and movement or allow an occasional catastrophic decline in abundance unrelated to fishery mortality). This does not fall under the intent of the present system but could have implications for long term management.

(6) Identification of beaked whale stocks: There is a need to develop methods to identify beaked whales killed incidental of fishing operations to species level. These methods must be performed easily on the deck of a small fishing vessel and other platforms at sea. Some possibilities include the collection of tissue, blood, tooth or jaw samples or skulls.

(7) Mixed species-stocks: There is a need to develop a method for calculating PBRs for mixed species groups (e.g., *Mesoplodon* sp.) when kill and/or census data can not be prorated to species and several species are known to be present.

(8) F_r CV value assessment: A method is needed to modify F_r values to explicitly account for the CV of the kill estimate. The idea is to allow a relaxation of F_r if kill estimates are considered to be precise.

(9) F_r tuning procedure: There is a need to develop a method for tuning the F_r to the level of uncertainty in the PBR elements for a specific stock.

(10) Survey correction factors: Species-specific correction factors need to be developed to correct sighting survey estimates for species with very long dive times and cryptic surfacing behavior (e.g., beaked whales).

(11) Stock sub-divisions: There is a need to evaluate the effects on PBR calculations and stock conservation of various levels of sub-division for stocks with broad geographical ranges, but for which there is no information on stock structure.

(12) Stock identification: Additional research is needed to progressively refine knowledge of population structure. Research should include gathering data, and analyzing and interpreting the data. Interpretation of such data will require modeling to address the power of assessing population structure as well.

(13) PBR bias and precision: There needs to be a general consideration of the effect of bias and the relationship between bias and precision in abundance estimates and kill estimates in relation to the PBR calculations.

References Not Provided as Background Documents

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Reilly, S. B., and J. Barlow. 1986. Rates of increase in dolphin population size. Fish. Bull. 84(3):527-533.

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PBR Workshop Appendix I: PBR Workshop Agenda, June 27-29, 1994, La Jolla, CA

Monday, June 27

1300-1310	Welcome and introductions (Tillman)
1310-1330	Appoint rapporteurs, review agenda and workshop Terms of Reference (Barlow)
1330-1345	Review "Principles for the Conservation of Wild Living Resources" and recent MMC review (Hofman/Mangle)
1345-1400	Review Goals and Objectives of the new MMPA (Barlow)
1415-1445	Discuss quantitative measures of success in meeting MMPA Goals (Taylor)
1445-1500	Break for coffee
1500-1600	Zero mortality rate goal - discussion of lessons learned from ETP tuna-dolphin program (Edwards), criteria for "success", minimum-threshold rate, skipper performance (Collins)
1600-1700	Summary and general discussion (Barlow).
1700	Break for dinner

Tuesday, June 28

0900-0915	Review PBR components and purpose in the "regime" (Eagle)
0915-1015	Nmin - Review of default values and alternative proposals for values (Hobbs), discuss criteria for selection of values (group)
1015-1030	Coffee Break
1030-1130	Rmax - Review of defaults, empirical estimates, alternatives, and criteria for selection of values (Barlow paper)
1130-1230	Recovery Factor - Review intent, default values, and criteria for selection (Barlow)
1230-1330	Break for lunch

1330-1430 Sensitivity tests of range of input values for PBR calculations (Wade)

1430-1600 Discuss approaches for calculating PBRs (group)

1600-1630 Summary of PBR discussion (Swartz/Barlow)

1630- 1700 Working group draft report on PBR approach

1700 Break for dinner

2000 (Optional) Working group continue to draft written summary of consensus on PBR (Swartz to convene)

Wednesday, June 29

0900-0930 Definition of "stock" in the MMPA; contrast and compare with a "management unit" (Hofman)

0930-1000 Rethinking the stock concept: A phylo-geographic approach (Dizon)

1000-1030 Stock identification criteria - biological, genetic, behavioral, seasonal, etc (Dizon)

1030-1100 Review and revise provisional stock lists for each region (Swartz)

1100-1115 Coffee Break

1115-1145 Alternative approaches to assessing stocks with imperfect or incomplete data on stock identification (Taylor)

1145-1215 Alternatives to assessing "trans-boundary" stocks (et al. IWC's "small area" approach, others (Gerrodette)

1215-1315 Lunch Break

1315-1600 Working groups draft reports:
a) Stock identification criteria
b) Zero mortality rate goal criteria

1600-1700 Presentation and review of working group reports

1700 Adjourn

PBR Workshop Appendix II: List of Participants

Carl Benz, U.S. Fish and Wildlife Service
Dana Seagers, U.S. Fish and Wildlife Service

Marc Mangel, Marine Mammal Commission
Robert Hofman, Marine Mammal Commission

Tom Eagle, NMFS Office Protected Resources

Steve Swartz, NMFS Senior Scientists Office

Kevin Collins, NMFS General Counsel

Gordon Waring, NMFS NEFSC

Ben Blaylock, NMFS SEFSC

Rod Hobbs, NMFS NMML
Robert Small, NRC NMML
James Lerczak, NMFS NMML

Michael Tillman, NMFS SWC

Robert Brownell, NMFS SWFSC
Jay Barlow, NMFS SWFSC
Andy Dizon, NMFS SWFSC
Susan Chivers, NMFS SWFSC
Karin Forney, NMFS SWFSC
Tim Gerrodette, NMFS SWFSC
Joyce Sisson, NMFS SWFSC
Barbara Taylor, NMFS SWFSC
Paul Wade, NRC SWFSC

Invited Observers

Irma Lagomarsino, NMFS SWR

Charlie Johnson, Indigenous People's Council for Marine Mammals

PBR Workshop Appendix III: Terms of Reference for the PBR Workshop

The recently re-authorized Marine Mammal Protection Act (MMPA) requires NMFS and FWS to complete stock assessment reports for most marine mammal species within U.S. waters by August 1, 1994. These stock assessments must include information on how stocks were defined, a calculation of Potential Biological Removals (PBRs), and an assessment of whether incidental fishery takes are "insignificant and approaching zero mortality and serious injury rate". The revised Act provides limited guidance for these items. The purpose of this workshop is to come to agreement on definitions for and how these items will be implemented in the development of the stock assessment reports. Clearly, there is a need to establish, where possible and appropriate, quantitative criteria that may be consistently applied to marine mammal stocks between Regions.

Our first priority, to define the elements to be used in calculating PBRs, is the principal charge of the workshop. We must also address the related issues of stock definition and "zero mortality rate goal." The agreements that we reach will be immediately applied to the drafting of the "draft" stock assessment reports for all marine mammals stock for which the Unites States has authority. These draft stock assessments must be available for public review and review by the three Regional Scientific Review Groups by August 1, 1994.

PBR Calculations

The 1994 amendments to the MMPA state that, as part of the stock assessment reports, NMFS must develop estimates of Potential Biological Removals (PBRs) for each marine mammal stock. These definitions and the logic behind them must be scientifically and legally defensible. Stock assessments are required to include calculations of PBRs (defined as a product of the minimum population estimate, half the maximum net productivity, and a recovery factor. This calculation is almost identical to that originally proposed by NMFS to Congress, except that the terms are now only generally defined. For example, the new Act does not say which percentile will be used to define minimum population size and states only that recovery factors shall be between 0.1 and 1.0. Clearly these can lead to considerable flexibility in the interpretation of the law and may lead to an unequal application of the law between Regions unless a nationwide standard and criteria for assigning values to these variables is adopted. One approach that the workshop will consider is to review the results of simulation trials used to test the sensitivity of the PBR algorithm to ranges of values for these input variables (see below).

(1) Minimum Population Estimate - N_{min}

The new Act defines "minimum population estimate" 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."

The original NMFS proposal defined minimum population size as the lower 95th percentile of a statistically-based population estimate or as an actual count (e.g. peak haul-out counts for pinnipeds). DeMaster is working on a revised scheme to define N_{min} as a constant fraction of the mean population estimate. The workshop needs to evaluate the relative benefits of each of these approaches.

(2) Maximum Net Productivity

The new act says that the PBR calculation shall include a second multiplicative term that is defined as "One-half the maximum theoretical or estimated net productivity rate of the stock at a small population size". The original NMFS proposal used a different terminology for this growth-rate term, basing it on the net productivity rate at the maximum net productivity level (MNPL); the NMFS proposal defined default values for net productivity rates at the MNPL (2% for cetaceans and manatees; 6% for pinnipeds and otters) to be used if specific information is lacking for a stock. The workshop needs to decide whether to use the same default (theoretical) values, use species specific information where available, or to consider other values. It also needs to establish criteria for determining when to go from default (theoretical) values to measured values (i.e., minimum levels of statistical precision).

(3) Recovery Factor

The 1994 amendments to the MMPA states only that PBR calculations shall include a third multiplicative term which is "A recovery factor of between 0.1 and 1.0"; it does not give guidance on how values for this factor are to relate to the status of a marine mammal population. The original NMFS proposal had 3 levels of safety factors: 0.1 for threatened and endangered species, 0.5 for depleted species or species of unknown status, and 1.0 for other species. DeMaster is investigating a scheme with just 2 levels: 0.2 for endangered, threatened or formally depleted and 1.0 for all others.

The workshop needs to determine how values for this factor are to be applied to stocks, and what decision rules or criteria are to be used to decide whether we should shift from one value to another. Simulation studies have already been completed to determine how well the NMFS proposal would work (Taylor 1993). DeMaster et al., (1994) are preparing another report documenting the performance of an alternative proposal.

(4) Integrating It All

The three PBR parameters cannot be evaluated independently; they must be evaluated together in the context of meeting the goals of the MMPA. For example, if recovery factors are very conservative, the definition of N_{min} can be less so and still provide an equivalent estimate of PBR. Barlow will discuss the results of his sensitivity tests of the effects of a range of values for these input parameters on PBR estimates. Another alternative would be to formulate an algorithm based on the values and CVs of the input values for N_{min} that would adjust the Recovery Factor accordingly (e.g., low abundance and high CV would be the most conservative case, high abundance and low CV would be the least conservative case).

Basis for Stock Structure

The workshop will use the definition of a "stock" provided in Section 3.11 of the MMPA as a starting point for a discussion of the biological basis for identifying a stock, and contrast this with alternative "management units" used as defaults for stocks when insufficient information exits to define a biological stock. We will also consider alternative assessment strategies for stocks that extends across international jurisdictional boundaries (e.g., pilot whales in California and Baja California). While PBRs could be calculated for an entire stock, there may not be a realistic mechanism to regulate human related mortality over the entire range of that stock. While this is strictly a management issue, it has scientific implications on how assessments of such stocks are developed. As a starting point, the workshop will concern itself with only those recognized stocks that occur entirely or for some portion of the time within the U.S. EEZ, noting those for which some portion of the stock may reside outside the U.S. EEZ some proportion of the time.

Another common problem with defining stocks is determining how much evidence is required before we decide whether we are dealing with one stock, two stocks, or many stocks. The workshop will review the criteria commonly used to define stocks (e.g., genetics, morphology, behavior, etc.), and discuss alternatives when sufficient data are not available to delineate individual stocks. One approach to consider is the use of "small areas" to deal with uncertainty in stock structure when calculating allowable removals as applied in the IWC's Revised Management Procedure Catch Limit Algorithm.

Zero Mortality Rate Goal

The revised MMPA requires that each stock assessment report must include the following for each commercial fishery which takes it:

> "(D) the rate, based on the appropriate standard unit of fishing effort, of such incidental mortality and serious injury, and an analysis stating whether such level is insignificant and is approaching a zero mortality and serious injury rate"

Unfortunately, the Act does not define what it means by an "insignificant and approaching zero" rate. The workshop will need to review the results of previous efforts to achieve "zero mortality" (e.g., ETP tuna dolphin), and determine the criteria on which this goal is to be evaluated. For example, this determination could be based on biological factors, a mean number killed per set without regard to population size or status, a percent of the stock killed, skipper performance, or some combination of these.

Quantitative Goals of the MMPA

The workshop will review the stated goals of the MMPA and the legislative record of Congressional intent, and based on these general goals, the workshop will address quantitative measures of how well these goals are being met by any proposed combination of PBR parameters, stock identification, and achieving the zero mortality rate.

PBR Workshop Appendix IV: Background Documents

(1) Holt, S .J. and L. M. Talbot. 1978. New principles for the conservation of wild living resources. Journal of Wildlife Management 43(2):1-33.

(2) Collins, K. 1994. Zero mortality rate goal legislative background. Workshop document.

(3) Taylor, B. L. 1993. "Best" abundance estimates and best management: why they are not the same. NOAA Tech. Memo. NMFS SWFSC-188.

(4) Lerczak, J. A., R. C. Hobbs, D. P. DeMaster, and B. L. Taylor. 1994. Evaluation of a proposed regime for calculating PBRs. Workshop document.

(5) Wade, P. R. 1994. Managing populations under the Marine Mammal Protection Act of 1994: A strategy for selecting values for N_{min}, the minimum abundance estimate, and F_r, the recovery factor. Workshop document.

(6) Draft List of Stocks for each Region.

(7) Dizon, A. E., C. Lockyer, W. F. Perrin, D. P. DeMaster, and J. Sisson. 1992. Rethinking the stock concept: A phylogeographic approach. Conservation Biology 6(1):24-35.

(8) Draft Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act; Request for Public Comment AGENCIES: Fish and Wildlife Service, Interior; National Marine Fisheries Service, Commerce.

(9) Waples, R. S. 1991. Definition of "species" under the Endangered Species Act: Application to Pacific Salmon. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-194.

(10) Taylor, B. L. 1994. The potential effects of overlooking stock structure for management under the 1994 Amendments to the Marine Mammal Protection Act. Workshop document.

(11) Barlow, J. and J. Sisson. 1994. The goals of the Marine Mammal Protection Act and their implications for estimating potential biological removals (PBR). Workshop document.

(12) Taylor, B. L. and D. P. DeMaster. 1994. Comparison of mortality limits of marine mammal management regimes. Workshop document.

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(14) Chivers, S. J., K. M. Peltier, W. T. Norman, P. A. Akin and J. E. Heyning. 1993. Population structure of cetaceans in California coastal waters. Workshop document.

(15) Brownell, R. L., Jr., and M. A. Donahue. 1994. Management problems for cetaceans found in both California and Mexican waters. Workshop document.

(16) Gosliner, M. 1994. Analysis of the 1994 Amendments to the Marine Mammal Protection Act of 1972. Marine Mammal Commission Report.

Part II. Summary of Analyses Used to Set Specific Values for N_{min} and F_r

This chapter provides a brief summary of the simulation analyses that were used to choose a specific percentile for calculating N_{min}, as well as for choosing a value for the recovery factor, $F_{r.}$ These analyses are described in full in Wade (1994), which followed the initial methods of Taylor (1993), which itself used the “base case” and “robustness” simulation trial approach used by the International Whaling Commission to select a Revised Management Procedure. Subsequent to Wade (1994), further simulations led to a modification to the value used for the recovery factor for cetacean stocks of unknown status, and so additionally, the basis for that modification is explained here.

Definition of PBR

The Marine Mammal Protection Act (MMPA) requires the calculation of a potential biological removal level for every stock of marine mammal in U.S. waters. The Act states:

"Sec.3 (20) The term potential biological removal level means the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. The potential biological removal level is the product of the following factors:

> (A) The minimum population estimate of the stock.
>
> B) One-half the maximum theoretical or estimated net productivity rate of the stock at a small population size
>
> (C) A recover factor between 0.1 and 1."

The MMPA (Sec.3(9)) defines the term "optimum sustainable population" to mean, "with respect to any population stock, the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element." For operational purposes, the National Marine Fisheries Service and the Fish and Wildlife Service have interpreted this definition to mean "a population size which falls within a range from the population level of a given species or stock which is the largest supportable within the ecosystem to the population level that results in maximum net productivity (MNP)." Maximum net productivity is defined as "the greatest net annual increment in population numbers or biomass resulting from additions to the population due to reproduction and/or growth less losses due to natural mortality" (50 C.F.R. § 216.3). Therefore, the intent of the simulation analyses was to calculate PBR so that populations would recover to and be maintained at or above maximum net productivity level (MNPL).

Although the MMPA specifies the three components of the PBR (i.e., a minimum population estimate, one-half the maximum net recruitment rate, and a recovery factor), it does not define them specifically in quantitative terms. Taylor (1993) considered a method for determining the PBR using a lower, 2-tailed, 95% confidence limit for N_{min}, which represents the 2.5th percentile of the distribution, and an F_r of 0.5, with ½R_{max} set as 0.02 to represent cetaceans and 0.06 to represent pinnipeds. The results of Taylor (1993) showed that using the lower confidence limit was superior to using the point estimate (the 50th percentile), when evaluated by the status of given simulated populations in 100 years. When subjected to "robustness trials", involving significant but plausible problems (such as bias in the abundance estimates), using the 2.5th percentile still resulted in populations being significantly above MNPL in 100 years.

The trials in Taylor (1993) resulted in nearly all trajectories being well above the maximum net productivity level. Therefore, Wade (1994) solved directly for the value of N_{min} (expressed as a percentile of the abundance estimate) and F_r that are sufficient to maintain populations within OSP.

Criteria for Selection of Values

Three criteria were used by Wade (1994) for selecting values for N_{min} and F_r:

(1) The percentile of the abundance estimate was chosen such that (A) any population, in the base case of an absence of significant problems, would be within OSP with 95% probability in 100 years, with an F_r equal to 1.0, and such that (B) a population starting at the lower bound of OSP (0.6K) would still be within OSP in 20 years with 95% probability.

(2) A default value for F_r for unknown status populations is chosen such that the above criteria (1A and 1B) are also met during robustness trials, in which the data are assumed to have specified problems, such as significant bias, that are unknown to the “managers”.

(3) A value of F_r for populations listed as endangered will be chosen such that the time to recovery of a depleted population is not more than 10% greater than populations that experience no incidental mortality, with 95% probability.

Simulation Trials and Results

Methods nearly identical to Taylor (1993) were used here for the simulations. A population was simulated using a discrete form of the generalized logistic equation. Cetaceans and pinnipeds were assumed to have maximum growth rates of 0.04 and 0.12, respectively. At intervals of a specified number of years, an estimate of abundance was "surveyed" by randomly sampling from the simulated population. A PBR was then calculated from that “survey”, and incidental fisheries mortality was simulated by assuming that it was equal, on average, to the entire PBR. The simulation was repeated 1,000 times for each trial, and the percentage of simulations where the population was at OSP after 20 and 100 years was recorded.

It was found that, over a range of abundance estimate CVs from 0.2-0.8, using the 20th percentile of the abundance estimate for N_{min} was sufficient to allow populations to recover to or remain within OSP, in the absence of problems such as biased estimates of abundance or mortality, and met both the 100-year and 20-year specified criteria. Further simulations (called “robustness trials”) were done assuming unknown bias or other problems, such as under-estimation of mortality by as much as 50%. These simulations indicated that a value of 0.50 for F_r for pinnipeds and 0.65 for cetaceans, in combination with using the 20th percentile of the abundance estimate, resulted in all populations equilibrating within OSP during the robustness trials.

The simulations of Wade (1994) used a maximum net productivity level (MNPL) of 60% of K, or carrying capacity. This level has often been used in marine mammal assessments because it is the mid-point, or close to it, of the presumed, but unknown, range of MNPL in marine mammals (Gerrodette and DeMaster 1990). However, it is thought that MNPL could be as low as 50% of K for some marine mammals, and if this was the true situation, a PBR based on model simulations using 60%K would lead to the depletion of such a population. On the other hand, if real world populations have a MNPL greater than what is used in simulations to select a value for calculating PBR, they would not become depleted because of incorrectly specifying MNPL. Instead, they would equilibrate at a higher fraction of K than they would otherwise. Therefore, the simulations were repeated for all cases using a value for MNPL of 50%. These results indicated a value for F_r of 0.5 was sufficient in the robustness trials to result in both the pinniped and cetacean trials to meet the specified 20 and 100 year criteria. Therefore, $F_r = 0.5$ was suggested as the default value for stocks that are depleted, threatened, or of unknown status.

To investigate the impact on recovery time for a depleted population, the percent increase in time to OSP (0.6K) for a population starting at 0.3K was calculated for a range of values of F_r. Assuming no substantial biases in the data, a value as low as 0.15 was required for F_r to result in all cases having 95% of their trajectories not delayed in time to recovery by more than 10%. No robustness trials were done for this recovery time analysis. To account for the possibility of additional unknown uncertainty, the lowest allowable value of 0.1 was suggested as an appropriate value for F_r for stocks listed as endangered.

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Part III: Guidelines for Preparing Stock Assessment Reports Pursuant to the 1994 Amendments to the Marine Mammal Protection Act

Introduction

Section 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. Stock Assessment 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 Stock Assessment Reports to include, among other things, information on how stocks were defined, 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 report provides guidance for how these topics are to be addressed in the Reports.

The MMPA amendments provide some general guidance, and more detailed guidelines were developed at the Government's PBR Workshop in June 1994 and were used in writing the original Draft Reports. These original guidelines together with the Draft PBR guidelines, were made available for public comment in August 1994. Subsequently, the MMPA Scientific Review Groups met jointly in October 1994 to review the Government's guidelines and to make recommendations for changes. This report is based on the original PBR Workshop guidelines as modified according to public comments and on the consensus recommendations from the Scientific Review Groups, FWS, and NMFS staff. 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 intend to convene a Stock Assessment Working Group, composed of scientists and managers from both agencies, to examine and recommend revision of the guidelines as part of the required 1-year and 3-year revisions of the Reports. Furthermore, the guidelines in this report do not have to be followed rigidly; however, any departure from this report must be discussed fully within any affected Stock Assessment 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 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 Marine Mammal Protection Act amendments and the PBR guidelines developed pursuant to the Act as a mechanism to respond to the greater degree of 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 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 or needs to be taken.

FWS and NMFS also believe that it is appropriate to develop management programs for stocks subject to subsistence harvests, but not significant commercial fisheries takes, through the Co-Management process provided that process includes a sound research and management program to identify and address uncertainties concerning marine mammal stocks subject to subsistence harvests. Therefore, estimates of PBR and "strategic" or "non-strategic" determinations have not been made at this time for certain Alaskan marine mammal stocks that:

(a) are not listed as endangered or threatened under the Endangered Species Act (ESA) or listed as depleted under the Marine Mammal Protection Act (MMPA);

(b) are subject to subsistence harvests by Alaska Natives but where mortality and serious injury incidental to commercial fishing is absent or is a relatively minor contribution to total human-related mortality and injury; and,

(c) where indicated in the draft Reports, are believed to have a total estimated human-related mortality that may not be sustainable over the long-term.

Estimates for PBR and status determinations for such stocks will be determined from the analysis of scientific and other relevant information discussed during the Co-management process, and these will maintain the intent of best available scientific information and reflect the degree of uncertainty associated with the information obtained for these stocks.

Definition of "Stock"

At the species level, taxonomy in the stock assessment reports should be consistent with Wilson and Reeder (1993) or more recent work. Below this level, the population "stock" is the fundamental unit of legally-mandated conservation efforts. The MMPA provides both biological and ecological guidance for making such determinations. The biological guidance is in the MMPA definition of population stock as "a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature." The ecological guidance is addressed in the requirement that a stock be maintained as a functioning element of the ecosystem. One clear intent of the MMPA is to restore and maintain stocks within their OSP. Therefore, stocks should be defined in a manner that is consistent with this goal.

A risk-averse strategy should be applied when determining the stock structure to be used for management. Typically this requires starting with a definition of stocks based on the smallest groupings which are biologically reasonable and are practical from a management perspective. In most cases, a biologically reasonable group would correspond to the underlying structure of the population. Many analyses can be used to elucidate the structure of populations: distribution and movements, population trends, morphological differences, genotypic differences, contaminants and natural isotope loads, parasite differences, and oceanographic/ habitat differences (Dizon et al. 1992; Perrin and Brownell 1994). Such groups can be subsequently combined or split further based on additional evidence from biological studies. However, in the absence of biological stock data, a stock should be defined to include only the area from which marine mammals are taken (i.e., the area in which a specific fishery is operating).

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 area unless there is evidence for movement of individuals between the EEZ and offshore pelagic areas.

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." PBR is, therefore, 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.

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

> (a) N_{min}, CV, 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.

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.

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).

Recovery Factor (F_r)

The MMPA defines the recovery factor, F_r, as being within the range from 0.1 to 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. 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 taken primarily by aboriginal subsistence hunters that are not known to be decreasing, 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. The default status should be considered as "unknown".

Clearly, projections of current abundance estimates become less dependable with time after a survey has occurred. Unless compelling evidence indicates that a stock has not declined since the last census, recovery factors should be reduced to account for the increasing uncertainty in the abundance estimate. If 5 years have transpired since the last abundance survey of a stock, the recovery factor for that stock should be decreased by 10 percent each subsequent year until a value of 0.1 is reached (e.g., where F_r was initially 1.0, after 5 years have passed since the most recent survey, the F_r would be 0.9 in year 6, in year 7 it would be 0.8, and so on). The annual decrement value of 10% per year is a rough approximation of the worst-case declines observed in marine mammal populations over decade-long periods. Note that the recovery factor cannot be reduced below its statutory lower limit of 0.1.

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 to 0.75 (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 or cases where the population is not known to be adversely affected by human interactions.

Mortality Rates

Section 118 of the 1994 MMPA Amendments reaffirmed the goal set forth in the Act when it was enacted in 1972 that the take of marine mammals in commercial fisheries is to be reduced to insignificant levels approaching zero mortality and serious injury rate, and further requires that this goal be met within 7 years of enactment of the 1994 Amendments. This goal will be referred to as the "zero mortality rate goal" (ZMRG).

Section 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. 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 first round of Stock Assessment 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. Stock Assessment Reports are not intended to be the literary vehicle for publicizing determinations as to whether a specific fishery has a mortality level that is insignificant and approaching zero; however, because FWS and NMFS are required to address this point for each fishery, 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 zero mortality and serious injury rate. This determination cannot be made for individual fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized."

There is a general view that marine mammal mortality information from logbook data can only be considered as a minimum estimate of mortality, although exceptions may occur. Logbook 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 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.

Status of Stocks

This section of the Stock Assessment Reports should present a summary of 5 types of "status": 1) legal status under the MMPA and ESA, 2) status relative to OSP (within OSP, depleted, or unknown), 3) designation of strategic or non-strategic, 4) a summary of trends in abundance and mortality, and (5) for those stocks where most or all of the human-related mortality is the result of subsistence harvests and where the level of human-caused mortality may not be sustainable (see section 1.0), a statement that a co-management approach will be used to assess the status of the stock.

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 available judgements, 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.

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Part IV: Summary of the 1995 Marine Mammal Stock Assessment Reports

The initial draft stock assessment reports for all of the stocks for which the National Marine Fisheries Service (NMFS) has responsibility for were made available in August, 1994, and a summary table of the estimated PBR and mortality by stock was published in the Federal Register (59 FR 40527). These initial stock assessment reports (SARs) were finalized and made available in July 1995, and published in three documents which each include all the NMFS stock assessment reports for the three regions corresponding to the regional Scientific Review Groups: Atlantic (including the Gulf of Mexico), Pacific (including Hawaii), and Alaska. The following is a summary of these final 1995 stock assessment reports, including the final PBR table published in the Federal Register in July 1995 (Table 1). For more detailed information on any particular stock, consult the appropriate stock assessment report: Atlantic and Gulf of Mexico stocks (Blaylock et al. 1995), Pacific stocks from California, Oregon, Washington, and Hawaii (Barlow et al. 1995), and Alaska stocks including the North Pacific (Small and DeMaster 1995).

Stock Definition

The first step in writing stock assessments is, of course, to define the stocks. The stock structure of cetaceans was typically based on their known distribution within one of 5 major areas of U.S. EEZ: the Atlantic coast of the continental U.S., the Gulf of Mexico, the Pacific coast of the continental U.S., Alaska, and Hawaii. These were reasonable stock areas for many species because of the different oceanographic habitats found between these areas, the large distances between these areas (especially in the Pacific), and because of the different fisheries that interact with marine mammals within these areas. Where additional biological information indicated a different stock structure was appropriate, smaller or larger stocks were defined. Such stocks included Pacific humpback whales, beluga whales, Pacific killer whales, Pacific harbor porpoise, and both Pacific and Atlantic bottlenose dolphins. Pinniped stocks were typically defined by the area of their haul-outs and rookeries. Where biological information indicated it was appropriate, multiple stocks were defined, including Steller sea lions, Northern fur seals, and Pacific harbor seals.

Summary of NMFS Stocks

A total of 145 stocks were defined for taxa that are under the authority of NMFS (Table 1), which are cetaceans and pinnipeds, excluding walrus. There are 60 marine mammal stocks in the Atlantic and Gulf of Mexico, 54 along the Pacific coast of the continental U.S. and Hawaii, and 31 in Alaska or the North Pacific. Further work on the definition of stock structure of many species was recognized as being needed, including Pacific and Atlantic harbor porpoise, Pacific killer whales, beluga whales, Atlantic bottlenose dolphins, and Pacific harbor seals. It is therefore anticipated that the number of stocks will change as additional information is collected and stock structure is revised.

Table 1. Summary of marine mammal stock assessments for stocks of marine mammals that are under NMFS authority. Included for each stock is its estimated minimum population size (N_{min}), maximum productivity rate (R_{max}), recovery factor (F_r), potential biological removal level (PBR), total annual human-caused mortality, annual incidental fisheries mortality, and strategic status (yes or no).

Species	Stock area	Region	NMFS Center	N_{min}	R_{max}	F_r	PBR	Total annual mort.	Annual fish. Mort.	Strategic Status
Steller sea lion	Western U.S.	AKA	AKC	42,536	0.12	0.3	766	555	41	Y
Steller sea lion	Eastern	AKA	AKC	23,533	0.12	0.75	1,059	8.0	4.0	Y
Northern fur seal	North Pacific	AKA	AKC	969,595	0.086	0.5	20,846	1,783	6.4	Y
Harbor seal	Southeast Alaska	AKA	AKC	32,745	0.12	1.0	1,965	1,643	N/A[1]	N
Harbor seal	Gulf of Alaska	AKA	AKC	N/D[2]	0.12	N/D	N/D	868	35	N/D
Harbor seal	Bering Sea	AKA	AKC	17,243	0.12	1.0	1,035	334	12	N
Spotted seal	Alaska	AKA	AKC	N/A	0.12	0.5	N/A	N/A	1.0	N
Bearded seal	Alaska	AKA	AKC	N/A	0.12	0.5	N/A	N/A	6.2	N
Ringed seal	Alaska	AKA	AKC	N/A	0.12	0.5	N/A	N/A	0.8	N
Ribbon seal	Alaska	AKA	AKC	N/A	0.12	0.5	N/A	N/A	0.4	N
Beluga	Beaufort Sea	AKA	AKC	38,194	0.04	1.0	764	160	0.00	N
Beluga	Eastern Chukchi Sea	AKA	AKC	3,710	0.04	1.0	74	65	0.00	N
Beluga	Norton Sound	AKA	AKC	N/D	0.04	N/D	N/D	147	0.00	N/D
Beluga	Bristol Bay	AKA	AKC	1,526	0.04	1.0	31	22	0.3	N
Beluga	Cook Inlet	AKA	AKC	N/D	0.04	N/D	N/D	N/A	0.00	N/D
Killer whale	Alaska and Washington Inland Waters, Resident	AKA	AKC	759	0.04	0.5	7.6	0.8	0.8	N
Killer whale	Alaska and Washington Inland Waters, Transient	AKA	AKC	245	0.04	0.5	2.4	0.8	0.8	N
Pacific white-sided dolphin	North Pacific	AKA	AKC	486,719	0.04	0.5	4,867	1.1	1.1	N
Harbor porpoise	Alaska	AKA	AKC	24,635	0.04	0.5	246	33	33	N
Dall's porpoise	Alaska	AKA	AKC	76,874	0.04	1.0	1,537	41	41	N
Sperm whale	Alaska	AKA	AKC	N/A	0.04	0.1	N/A	0.00	0.00	Y
Baird's beaked whale	Alaska	AKA	AKC	N/A	0.04	0.5	N/A	0.00	0.00	N
Cuvier's beaked whale	Alaska	AKA	AKC	N/A	0.04	0.5	N/A	0.00	0.00	N
Stejnerger's beaked whale	Alaska	AKA	AKC	N/A	0.04	0.5	N/A	0.00	0.00	N
Gray whale	Eastern North Pacific	AKA	AKC	21,715	0.04	1.0	434	0.3	0.3	N
Humpback whale	Western North Pacific	AKA	AKC	N/A	0.04	0.1	N/A	0.00	0.00	Y
Humpback whale	Central North Pacific	AKA	AKC	1,407	0.04	0.1	2.8	0.00	0.00	Y
Fin whale	N. Pacific	AKA	AKC	N/A	0.04	0.1	N/A	0.00	0.00	Y

[1]Logbook records indicate commercial fisheries cause a minimum annual mortality of 6 seals for this stock. N/A means that actual estimates are unknown or not available.

[2]N/D indicates an estimate was not determined. NMFS will determine these values after considering relevant information through the co-management process with affected Alaska Native organizations.

Species	Stock area	Region	NMFS Center	N_{min}	R_{max}	F_r	PBR	Total annual mort.	Annual fish. Mort.	Strategic Status
Minke whale	Alaska	AKA	AKC	N/A	0.04	0.5	N/A	0.00	0.00	N
Northern right whale	North Pacific	AKA	AKC	N/A	0.04	0.1	0.00	0.00	0.00	Y
Bowhead whale	Western Arctic Stock	AKA	AKC	7,524	0.04	0.5	75[3]	42	0.00	Y
North Atlantic right whale	Western North Atlantic	ATL	NEC	295	0.025	0.1	0.4	2.6	1.6	Y
Humpback whale	Western North Atlantic	ATL	NEC	4,848	0.04	0.1	9.7	1.0	1.0	Y
Fin whale	Western North Atlantic	ATL	NEC	1,704	0.04	0.1	3.4	N/A	0.00	Y
Sei whale	Western North Atlantic	ATL	NEC	N/A	0.04	0.1	N/A	0.00	0.00	Y
Minke whale	Canadian east coast	ATL	NEC	2,053	0.04	0.5	21	2.5	2.5	N
Blue whale	Western North Atlantic	ATL	NEC	N/A	0.04	0.1	N/A	0.00	0.00	Y
Sperm whale	Western North Atlantic	ATL	NEC	226	0.04	0.1	0.5	1.6	1.6	Y
Dwarf sperm whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	N/A	N/A	Y
Pygmy sperm whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	N/A	N/A	Y
Killer whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	0.00	0.00	N
Pygmy killer whale	Western North Atlantic	ATL	SEC	6	0.04	0.5	0.1	0.00	0.00	N
Northern bottlenose whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	0.00	0.00	N
Cuvier's beaked whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	34	34[4]	Y
True's beaked whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	34	34	Y
Gervais' beaked whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	34	34	Y
Blainville's beaked whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	34	34	Y
Sowerby's beaked whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	34	34	Y
Risso's dolphin	Western North Atlantic	ATL	NEC	11,140	0.04	0.5	111	68	68	N
Pilot whale, long-finned	Western North Atlantic	ATL	NEC	3,537	0.04	0.4	28	109	109[5]	Y
Pilot whale, short-finned	Western North Atlantic	ATL	NEC	457	0.04	0.5	3.7	109	109[5]	Y

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[3]The IWC subsistence quota is not affected by the calculation of PBR using the formula specified in the MMPA.

[4]This is the average mortality of beaked whales (Mesoplodon sp.) based on 5 years of observer data. This annual mortality rate may include an unknown number of Cuvier's beaked whales.

[5]Mortality data are not separated by species; therefore, species-specific estimates are not available. The mortality estimate represents both short- and long-finned pilot whales.

Species	Stock area	Region	NMFS Center	N_{min}	R_{max}	F_r	PBR	Total annual mort.	Annual fish. Mort.	Strategic Status
Atlantic white-sided dolphin	Western North Atlantic	ATL	NEC	12,538	0.04	0.5	125	127	127	Y

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White-beaked dolphin	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	0.00	0.00	N
Common dolphin	Western North Atlantic	ATL	NEC	3,233	0.04	0.5	32	449	449	Y
Atlantic spotted dolphin	Western North Atlantic	ATL	NEC	4,885	0.04	0.1	N/A	31[6]	31[6]	Y
Pantropical spotted dolphin	Western North Atlantic	ATL	NEC	N/A	N/A	N/A	N/A	31[6]	31[6]	Y
Striped dolphin	Western North Atlantic	ATL	NEC	9,165	0.04	0.4	73	63	63	N
Spinner dolphin	Western North Atlantic	ATL	NEC	N/A	N/A	N/A	N/A	1.0	1.0	N
Bottlenose dolphin	Western North Atlantic, Offshore	ATL	NEC	9,195	0.04	0.5	92	128	128	Y
Bottlenose dolphin	Western North Atlantic, Coastal	ATL	SEC	2,482	0.04	0.5	25	29	29	Y
Harbor porpoise	Gulf of Maine/Bay of Fundy	ATL	NEC	40,297	0.04	0.5	403	1,876	1,876	Y
Harbor seal	Western North Atlantic	ATL	NEC	28,810	0.12	1.0	1,729	476	476	N
Gray seal	Northwest North Atlantic	ATL	NEC	2,035	0.12	1.0	122	4.5	4.5	N
Harp seal	Northwest North Atlantic	ATL	NEC	N/A	N/A	N/A	N/	0.00	0.00	N
Hooded seal	Northwest North Atlantic	ATL	NEC	N/A	N/A	N/A	N/A	0.00	0.00	N
Sperm whale	Northern Gulf of Mexico	ATL	SEC	411	0.04	0.1	0.8	0.00	0.00	Y
Bryde's whale	Northern Gulf of Mexico	ATL	SEC	17	0.04	0.5	0.2	0.00	0.00	N
Cuvier's beaked whale	Northern Gulf of Mexico	ATL	SEC	20	0.04	0.5	0.2	0.00	0.00	N
Blainville's beaked whale	Northern Gulf of Mexico	ATL	SEC	N/A	N/A	N/A	N/A	0.00	0.00	N
Gervais' beaked whale	Northern Gulf of Mexico	ATL	SEC	N/A	N/A	N/A	N/A	0.00	0.00	N
Bottlenose dolphin	Gulf of Mexico, Outer Continental Shelf	ATL	SEC	43,233	0.04	0.5	432	2.8	2.8[7]	N
Bottlenose dolphin	Gulf of Mexico, Continental Shelf Edge and Slope	ATL	SEC	4,530	0.04	0.5	45	2.8	2.8[7]	N
Bottlenose dolphin	Western Gulf of Mexico Coastal	ATL	SEC	2,938	0.04	0.5	29	13	13[8,9]	N

[6]This value includes either or both of *Stenella frontalis* or *Stenella attenuata*.

[7]This value may include either or both of the Gulf of Mexico, Continental Shelf Edge and Slope and the Outer Continental Shelf stocks of bottlenose dolphins.

[8]Low levels of bottlenose dolphin mortaality (0-4 per year) incidental to commercial fisheries have been reported. It is unknown to which stock this mortality can be attributed.

[9]Estimates derived from stranded animals with signs of fishery interactions, and these could be either coastal or estuary stocks.

Species	Stock area	Region	NMFS Center	N_{min}	R_{max}	F_r	PBR	Total annual mort.	Annual fish. Mort.	Strategic Status
Bottlenose dolphin	Northern Gulf of Mexico Coastal	ATL	SEC	3,518	0.04	0.5	35	10	10[9]	N
Bottlenose dolphin	Eastern Gulf of Mexico Coastal	ATL	SEC	8,963	0.04	0.5	90	8	8[9]	N
Bottlenose dolphin	Gulf of Mexico Bay, Sound, and Estuarine[10]	ATL	SEC	3,934	0.04	0.5	39.7	30	30[9]	Y
Atlantic spotted dolphin	Northern Gulf of Mexico	ATL	SEC	2,255	0.04	0.5	23	1.5[5]	1.5[5]	N
Pantropical spotted dolphin	Northern Gulf of Mexico	ATL	SEC	26,510	0.04	0.5	265	1.5[5]	1.5[5]	N
Striped dolphin	Northern Gulf of Mexico	ATL	SEC	3,409	0.04	0.5	34	0.00	0.00	N
Spinner dolphin	Northern Gulf of Mexico	ATL	SEC	4,465	0.04	0.5	45	0.00	0.00	N
Rough-toothed dolphin	Northern Gulf of Mexico	ATL	SEC	660	0.04	0.5	6.6	0.00	0.00	N
Clymene dolphin	Northern Gulf of Mexico	ATL	SEC	4,120	0.04	0.5	41	0.00	0.00	N
Fraser's dolphin	Northern Gulf of Mexico	ATL	SEC	66	0.04	0.5	0.7	0.00	0.00	N
Killer whale	Northern Gulf of Mexico	ATL	SEC	197	0.04	0.5	2.0	0.00	0.00	N
False Killer whale	Northern Gulf of Mexico	ATL	SEC	236	0.04	0.5	2.4	0.00	0.00	N
Pygmy killer whale	Northern Gulf of Mexico	ATL	NEC	285	0.04	0.05	2.8	0.00	0.00	N
Dwarf sperm whale	Northern Gulf of Mexico	ATL	SEC	N/A	0.04	N/A	N/A	0.00	0.00	Y
Pygmy sperm whale	Northern Gulf of Mexico	ATL	SEC	N/A	0.04	N/A	N/A	0.00	0.00	Y
Melon-headed whale	Northern Gulf of Mexico	ATL	SEC	2,888	0.04	0.5	29	0.00	0.00	N
Risso's dolphin	Northern Gulf of Mexico	ATL	SEC	2,199	0.04	0.5	22	19	19	N
Pilot whale, short-finned	Northern Gulf of Mexico	ATL	SEC	186	0.04	0.5	1.9	0.3	0.3	Y
California sea lion	U.S.	PAC	SWC	84,195	0.12	1.0	5,052	2,446	2,446	N
Harbor seal	California	PAC	SWC	32,798	0.12	1.0	1,968	729	729	N
Harbor seal	Oregon/ Washington coast	PAC	AKC	28,322	0.12	1.0	1,699	233	233	N
Harbor seal	Washington Inland waters	PAC	AKC	13,053	0.12	1.0	783	29	29	N
Northern elephant seal	California breeding	PAC	SWC	42,000	0.086	1.0	1,743	166	166	N
Guadalupe fur seal	Mexico to California	PAC	SWC	3,028	0.137	0.5	104	0.00	0.00	Y

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[10]This entry encompasses 33 stocks of bottlenose dolphins. All stocks are considered strategic; see the full report for information on individual stocks. The listed estimates for abundance, PBR and mortality are sums across all bays, sounds, and estuaries.

Species	Stock area	Region	NMFS Center	N_{min}	R_{max}	F_r	PBR	Total annual mort.	Annual fish. Mort.	Strategic Status
Northern fur seal	San Miguel Island	PAC	AKC	10,536	0.086	0.5	227	0.00	0.00	N
Hawaiian monk seal	Hawaii	PAC	SWC	1,300	0.06	0.1	3.9[11]	N/A	N/A	Y

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Harbor porpoise	Central California	PAC	SWC	3,430	0.04	0.5	34	31	31	N
Harbor porpoise	Northern California	PAC	SWC	7,640	0.04	0.5	76	0.00	0.00	N
Harbor porpoise	Oregon/ Washington coast	PAC	AKC	22,049	0.04	0.5	220	14	14	N
Harbor porpoise	Inland Washington	PAC	AKC	2,680	0.04	0.5	27	16	16	N
Dall's porpoise	California/ Oregon/ Washington	PAC	SWC	58,902	0.04	0.5	589	36	36	N
Pacific white-sided dolphin	California/ Oregon/ Washington	PAC	SWC	82,939	0.04	0.5	829	28	28	N
Risso's dolphin	California/ Oregon/ Washington	PAC	SWC	22,388	0.04	0.5	224	39	39	N
Bottlenose dolphin	California coastal	PAC	SWC	245	0.04	0.5	2.5	0.00	0.00	N
Bottlenose dolphin	California/Oregon/ Washington Offshore	PAC	SWC	1,775	0.04	0.5	18	7.7	7.7	N
Striped dolphin	California/ Oregon/ Washington	PAC	SWC	13,639	0.04	0.5	136	0.00	0.00	N
Common dolphin, short-beaked	California/ Oregon/ Washington	PAC	SWC	179,185	0.04	0.5	1,792	316	316[12]	N
Common dolphin, long-beaked	California	PAC	SWC	5,636	0.04	0.5	56	23	23[12]	N
Northern right whale dolphin	California/ Oregon/ Washington	PAC	SWC	15,080	0.04	0.5	151	46	46	N
Killer whale	California/ Oregon/ Washington	PAC	SWC	139	0.04	0.5	1.4	0.00	0.00	N
Pilot whale, short-finned	California/ Oregon/ Washington	PAC	SWC	N/A	0.04	0.5	N/A	36	36	Y
Baird's beaked whale	California/ Oregon/ Washington	PAC	SWC	19	0.04	0.5	0.2	0.00	0.00[13]	Y
Mesoplodont beaked whales	California/ Oregon/ Washington	PAC	SWC	136	0.04	0.5	1.4	7.7	7.7	Y
Cuvier's beaked whale	California/ Oregon/ Washington	PAC	SWC	886	0.04	0.5	8.9	24	24	Y
Pygmy sperm whale	California/ Oregon/ Washington	PAC	SWC	481	0.04	0.5	4.8	5.7	5.7	Y

[11]Although the calculated PBR is 3.9, the allowable take is zero due to findings under the ESA.

[12]This value includes 6 animals that could not be specified as either short- or long-beaked common dolphins.

[13]Mortality for 1991-1993 was zero; two Baird's beaked whales were observed taken in 1994. This exceeds PBR.

Species	Stock area	Region	NMFS Center	N_{min}	R_{max}	F_r	PBR	Total annual mort.	Annual fish. Mort.	Strategic Status
Dwarf sperm whale	California/ Oregon/ Washington	PAC	SWC	N/A	0.04	0.5	N/A	0.00	0.00	N
Sperm whale	California to Washington	PAC	SWC	512	0.04	0.1	1.0	17	17	Y
Humpback whale	California/ Mexico	PAC	SWC	563	0.04	0.1	0.5	1.16	0.5	Y
Blue whale	California/ Mexico	PAC	SWC	1,709	0.04	0.1	1.7	N/A	N/A	Y
Fin whale	California to Washington	PAC	SWC	575	0.04	0.1	1.1	<1	0.00	Y
Bryde's whale	Eastern Tropical Pacific	PAC	SWC	11,163	0.04	0.5	0.5[14]	N/A	0.00	N
Sei whale	Eastern North Pacific	PAC	SWC	N/A	0.04	0.1	N/A	N/A	0.00	Y
Minke whale	California/ Oregon/ Washington	PAC	SWC	265	0.04	0.5	2.6	0.5	0.5	N
Rough-toothed dolphin	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A	N/A	N
Risso's dolphin	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A	N/A	N
Bottlenose dolphin	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	0.00	0.00	N
Pantropical spotted dolphin	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A	N/A	N
Spinner dolphin	Hawaii	PAC	SWC	677	0.04	0.5	6.8	N/A	N/A	N
Striped dolphin	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A	N/A	N
Melon-headed whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	0.00	0.00	N
Pygmy killer whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A	N/A	N
False killer whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A	N/A	N
Killer whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	0.00	0.00	N
Pilot whale, short-finned	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A	N/A	N
Blainville's beaked whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	0.00	0.00	N
Cuvier's beaked whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A	0.00	N
Pygmy sperm whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	N/A	N/A	N
Dwarf sperm whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	0.00	0.00	N
Sperm whale	Hawaii	PAC	SWC	N/A	0.04	0.1	N/A	N/A	0.00	Y
Blue whale	Hawaii	PAC	SWC	N/A	0.04	0.1	N/A	N/A	N/A	Y
Fin whale	Hawaii	PAC	SWC	N/A	0.04	0.1	N/A	0.00	0.00	Y
Bryde's whale	Hawaii	PAC	SWC	N/A	0.04	0.5	N/A	0.00	0.00	N

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[14]This PBR has been adjusted because only 0.5% of this stock is estimated to be in U.S. waters.

Summary of FWS Stocks

A total of eight stocks were defined for the taxa that are under the authority of the U.S. Fish and Wildlife Service (FWS), which are walrus, sea otters, polar bears, and manatees. Although this document was written by NMFS biologists, for completeness, a summary of the assessments for the eight FWS stocks is provided here (Table 2). FWS stocks will not be considered further in this section.

Table 2. Summary of stock assessments for marine mammals under FWS authority.

Species	Stock area	SRG Region	FWS Region	N_{min}	R_{max}	F_r	PBR	Total annual mort.	Annual fish. Mort.	Strategic Status
Polar bear	Chukchi and Bering Seas, Alaska and Russia	AKA	7	N/A	N/A	1.0	N/A	55	0	N
Polar bear	Beaufort Sea: Alaska and Canada	AKA	7	1,579	0.06	1.0	72[1]	63	0	N
Sea otter	Alaska	AKA	7	100,000	0.2	1.0	10,000	506	1	N
Pacific walrus	Alaska and Russia	AKA	7	188,316	0.08	1.0	7,533	5,894	16	N
West Indian manatee	SE USA (Florida)	ATL	4	1,822	0.04	0.1	3	49[2]	1	Y
West Indian manatee	Antillean (Puerto Rico)	ATL	4	86	0.04	0.1	0	2	N/A	Y
Southern sea otter	Central Calif. and San Nicolas Island	PAC	1	2,376	0.06	0.1	N/AP[3]	N/A	N/A	Y
Sea otter	Neah Bay to Destruction Island, WA	PAC	1	360	0.12	0.5	11	N/A	N/A	N

NMFS Stocks Designated Strategic

Stocks Designated Strategic with Estimates of Incidental Fisheries Mortality > PBR

Along the Atlantic coast of the continental U.S. there are 16 stocks that are strategic because incidental fisheries mortality exceeds their calculated PBR, out of a total of 34 stocks (Table 3). Three of those 16 stocks are also strategic because they are listed under the ESA or MMPA. The Gulf of Maine harbor porpoise has fisheries mortality estimated to be 4.65 times its PBR (Table 4). The fishery primarily responsible for this mortality is the Gulf of Maine sink gillnet fishery, which was also mainly responsible for the strategic designation of Atlantic white-sided dolphins. The Atlantic drift gillnet fishery for swordfish/tuna/shark is primarily responsible for 13 stocks being strategic, but significant mortality of some of these stocks also occurs in the Atlantic pair-trawl fishery for swordfish/tuna/shark, the Atlantic longline fishery for swordfish/tuna/billfish, the New England groundfish multispecies trawl fishery, and possibly also in the Atlantic mid-water trawl fisheries for mackerel and for squid. Some of these stocks may be strategic only because of species identification difficulties and under-estimation of abundance (see below). The U.S. Atlantic coastal gillnet fishery was thought to be the source of incidental mortality estimated from strandings that exceeds the PBR of Atlantic coastal bottlenose dolphins, as well as being responsible for additional mortality of harbor porpoise. None of the 26 stocks in the Gulf of Mexico have estimates of

[1]Adjusted upward to 72 animals from the calculated PBR of 48 to reflect the approximate 2 male:1 female sex ratio of the harvest.

[2]Estimated average human-caused mortality for the West Indian manatee-Florida stock from 1984-1992. The estimated average annual human-caused mortality from 1974-1992 is 36 animals.

[3]N/AP means not applicable. Although the caluclated PBR is 7, incidental take is not goverered under section 118 or 101(a)(5)(E) of the MMPA.

incidental fisheries mortality greater than their PBR. However, 4 stocks were designated strategic (see below).

Table 3. Summary of stocks that are strategic because their estimate of total annual incidental fisheries mortality exceeds their estimated PBR. If a stock is additionally listed under the ESA or MMPA, that is indicated.

Species	Stock	Listing status
North Atlantic right whale	W. North Atlantic	Endangered
Sperm whale	W. North Atlantic	Endangered
Cuvier's beaked whale	W. North Atlantic	
True's beaked whale	W. North Atlantic	
Gervais' beaked whale	W. North Atlantic	
Blainville's beaked whale	W. North Atlantic	
Sowerby's beaked whale	W. North Atlantic	
Pilot whale, long-finned	W. North Atlantic	
Pilot whale, short-finned	W. North Atlantic	
Atlantic white-sided dolphin	W. North Atlantic	
Common dolphin	W. North Atlantic	
Atlantic spotted dolphin	W. North Atlantic	
Pantropical spotted dolphin	W. North Atlantic	
Bottlenose dolphin	W. North Atlantic, offshore	
Bottlenose dolphin	W. North Atlantic, coastal	Depleted
Harbor porpoise	Gulf of Maine/Bay of Fundy	
Sperm whale	CA/OR/WA	Endangered
Humpback whale	CA/OR/WA-Mexico	Endangered
Pilot whale, short-finned	CA/OR/WA	
Baird's beaked whale	CA/OR/WA	
Mesoplodont beaked whales	CA/OR/WA	
Cuvier's beaked whale	CA/OR/WA	
Pygmy sperm whale	CA/OR/WA	

Along the Pacific coast of the continental U.S., 7 stocks out of a total of 34 are strategic because of incidental fisheries mortality that exceeds their calculated PBRs (Table 3). Their incidental mortality is nearly exclusively from the California/Oregon/Washington drift gillnet fishery for swordfish and shark (Table 4). Two of these stocks are also strategic because they are listed as endangered under the ESA. None of the the 20 Hawaii stocks or 31 Alaska stocks have incidental fisheries mortality that exceeds their calculated PBRs.

Table 4. Incidental mortality of marine mammal stocks in selected fisheries which interact substantially with stocks which have total incidental mortality > PBR (potential biological removal level). Mortality is the estimate of annual mortality in that fishery reported in the stock assessments. Estimates are generally from observer program data. LB stands for logbook data which documents unquantified mortality in that fishery. ST stands for stranding data which indicates mortality in that fishery. AN stands for mortality is suspected by analogy to a similar fishery known to have mortality of that species or stock. Mortality in brackets is for a category of pooled stocks; such stocks are shown sequentially in the table. M/PBR is the ratio of the mortality estimate to the calculated PBR, which is also shown.

Fishery / Stock	Status	Mortality	M/PBR	PBR
New England multispecies sink gillnet fishery (observer program 1990-93)				
Harbor porpoise, Gulf of Maine/Bay of Fundy	Strategic	1875	4.65	403
Atlantic white-sided dolphin, W. North Atlantic	Strategic	102	0.82	125
Harbor seal, W. North Atlantic		476	0.28	1729
Minke whale, Canadian east coast		2.5	0.12	21
Gray seal, NW North Atlantic		4.5	0.04	122
Atlantic pelagic drift gillnet for swordfish/tuna/shark (observer program 1989-93)				
Common dolphin, W. North Atlantic	Strategic	424	13.25	32
Cuvier's beaked whale, W. North Atlantic	Strategic	[34]	-	-
True's beaked whale, W. North Atlantic	Strategic	[34]	-	-
Gervais' beaked whale, W. North Atlantic	Strategic	[34]	-	-
Blainville's beaked whale, W. North Atlantic	Strategic	[34]	-	-
Sowerby's beaked whale, W. North Atlantic	Strategic	[34]	-	-
North Atlantic right whale, W. North Atlantic	Strategic	1.6	4	0.4
Sperm whale, W. North Atlantic	Strategic	1.6	3.2	0.5
Atlantic spotted dolphin, W. North Atlantic	Strategic	[22.6]	2.31	9.8
Pantropical spotted dolphin, W. North Atlantic	Strategic	[22.6]	-	-
Pilot whale, long-finned, W. North Atlantic	Strategic	[61]	2.18	28
Pilot whale, short-finned, W. North Atlantic	Strategic	[61]	-	3.7
Bottlenose dolphin, W. North Atlantic, offshore	Strategic	53	0.58	92
Risso's dolphin, W. North Atlantic		59	0.53	111
Striped dolphin, W. North Atlantic		27	0.37	73
Humpback whale, W. North Atlantic	Strategic	1	0.1	9.7

Fishery / Stock	Status	Mortality	M/PBR	PBR
Atlantic white-sided dolphin, W. North Atlantic	Strategic	3.1	0.02	125
Spinner dolphin, W. North Atlantic		1.4	-	-
Harbor porpoise, Gulf of Maine/Bay of Fundy	Strategic	1	0	403

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Fishery / Stock	Status	Mortality	M/PBR	PBR
Dwarf sperm whale, W. North Atlantic	Strategic	LB	-	-
Pygmy sperm whale, W. North Atlantic	Strategic	LB	-	-
Atlantic mid-water trawl fisheries (for mackerel and squid, logbook data 1990-92, analogy to foreign fish.)				
Pilot whale, long-finned, W. North Atlantic	Strategic	LB	-	28
Atlantic white-sided dolphin, W. North Atlantic	Strategic	LB	-	125
Common dolphin, W. North Atlantic	Strategic	AN	-	32
Bottlenose dolphin, W. North Atlantic, offshore	Strategic	AN	-	92
Risso's dolphin, W. North Atlantic		AN	-	111
New England groundfish multispecies trawl fishery (observer program 1989-93)				
Pilot whale, long-finned, W. North Atlantic	Strategic	37	1.32	28
Striped dolphin, W. North Atlantic		36	0.49	73
Atlantic white-sided dolphin, W. North Atlantic	Strategic	22	0.18	125
Bottlenose dolphin, W. North Atlantic, offshore	Strategic	18	0.2	92
Atlantic pair trawl fishery for swordfish/ tuna/shark (observer program 1991-93)				
Common dolphin, W. North Atlantic	Strategic	24	0.75	32
Bottlenose dolphin, W. North Atlantic, offshore	Strategic	57	0.62	92
Risso's dolphin, W. North Atlantic		2.7	0.02	111
Pilot whale, long-finned, W. North Atlantic	Strategic	LB	-	28
Atlantic pelagic longline fishery for swordfish/tuna/billfish (observer program 1992-93)				
Atlantic spotted dolphin, W. North Atlantic	Strategic	[8]	0.82	9.8
Pantropical spotted dolphin, W. North Atlantic	Strategic	[8]	-	-
Pilot whale, long-finned, W. North Atlantic	Strategic	[11]	0.39	28

Fishery / Stock	Status	Mortality	M/PBR	PBR
Pilot whale, short-finned, W. North Atlantic	Strategic	[11]	-	3.7
Risso's dolphin, W. North Atlantic		6.5	0.06	111
U.S. Atlantic coastal gillnet fishery (stranding data 1988-93)				
Bottlenose dolphin, W. North Atlantic, coastal	Strategic	21,ST	0.84	25
Harbor porpoise, Gulf of Maine/Bay of Fundy	Strategic	ST	-	403
Humpback whale, W. North Atlantic	Strategic	ST	-	9.7
Gulf of Mexico pelagic longline fishery for swordfish/ tuna/billfish (observer program 1992-93)				
Risso's dolphin, N.Gulf of Mexico		19	0.86	22

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Pilot whale, short-finned, N. G.Mex	Strategic	0.3	0.16	1.9
Atlantic spotted dolphin, N.Gulf of Mexico		[1.5]	0.07	23
Pantropical spotted dolphin, N.Gulf of Mexico		[1.5]	0.01	265
Bottlenose dolphin, G.Mex.,Cont.Shelf Edge/Slope		[2.8]	0.06	45
Bottlenose dolphin, G.Mex.,Outer Cont. Shelf		[2.8]	0.01	432
Gulf of Mexico coastal fisheries (stranding data 1988-93, uncertain fisheries source)				
Bottlenose dolphin, G. Mex., Bays, Sounds, and Estuaries	Strategic	[30],ST	-	39.7
Bottlenose dolphin, G.Mex., western coastal		[13],ST	-	29
Bottlenose dolphin, G.Mex., northern coastal		[10],ST	-	35
Bottlenose dolphin, G.Mex., eastern coastal		[8],ST	-	90
California drift gillnet fishery for swordfish/shark (observer program 1991-93)				
Sperm whale, CA/OR/WA	Strategic	17	17	1
Mesoplodont beaked whales, CA/OR/WA	Strategic	7.7	5.5	1.4
Cuvier's beaked whale, CA/OR/WA	Strategic	24	2.7	8.9
Baird's beaked whale, CA/OR/WA	Strategic	0.5	2.5	0.2
Pygmy sperm whale, CA/OR/WA	Strategic	5.7	1.2	4.8
Humpback whale, CA/OR/WA-Mexico	Strategic	0.5	1	0.5
Pilot whale, short-finned, CA/OR/WA	Strategic	36	-	-
Bottlenose dolphin, CA/OR/WA offshore		7.7	0.43	18

Fishery / Stock	Status	Mortalit y	M/PBR	PBR
Common dolphin, long-beaked, California		17	0.30	56
Northern right whale dolphin, CA/OR/WA		46	0.30	151
Minke whale, CA/OR/WA		0.5	0.19	2.6
Common dolphin, short-beaked, CA/OR/WA		310	0.17	1792
Risso's dolphin, CA/OR/WA		39	0.17	224
Dall's porpoise, CA/OR/WA		36	0.06	589
Northern elephant seal, California		102	0.06	1743
Pacific white sided dolphin, CA/OR/WA		28	0.03	829
California sea lion, U.S.		64	0.02	5052

Stocks Designated Strategic Because They are Listed as Endangered, Threatened, or Depleted

Stocks that are listed as endangered or threatened under the Endangered Species Act or are designated as depleted under the Marine Mammal Protection Act are also automatically designated as strategic. Blue, Fin, Sei, Humpback, Right, Bowhead, and Sperm whales were all listed as endangered in the 1970's, mostly because they were considered depleted due to commercial whaling harvests. There are 20 stocks from these seven species in U.S. waters, and they are all therefore designated strategic. None of these stocks are known to be commercially harvested at this time.

In the Atlantic, there are six whale stocks that are strategic because they are listed as endangered under the ESA. Two of these stocks (right whales and sperm whales) currently have incidental fisheries mortality that is greater than their PBR (discussed above). Of the four other listed whale stocks, humpback whales have some significant human-caused mortality from ship strikes and fisheries mortality, but there does not appear to be any significant current mortality of blue, fin or sei whales Additionally, coastal bottlenose dolphins in the Atlantic were designated depleted after the 1987-88 anomalous mortality event.

Sperm whales in the Gulf of Mexico are strategic because they are listed as endangered under the ESA. There is no human-caused mortality of this stock known currently. Some boats in the Atlantic drift gillnet fishery have operated in the Gulf of Mexico, so there is the potential for fisheries mortality of sperm whales there as that fishery is documented to take sperm whales in the western North Atlantic.

Five stocks of whales along the Pacific coast of the U.S. are listed as endangered. Two of those stocks, sperm whales and humpback whales, have incidental fisheries mortalty that is greater than their PBR. The three other stocks of listed large whales in this area (blue, fin, and sei) are not known to have high levels of human-caused mortality, although there have been documented mortalities of blue and fin whales from ship strikes. Additionally, there have been documented mortalites of unidentified large whales in the drift gillnet fishery that could have been one of these species, and much of the gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net. The Guadalupe fur seal is listed as threatened because of its depletion from commercial sealing in the 19th century. There are no known current human-caused mortalities of this stock.

Two whales stocks in Hawaii, blue and fin whales, are strategic because they are listed as endangered under the ESA (the central North Pacific humpback whale stock is discussed under Alaska stocks, below). Currently there are no known human-caused mortalities of these stocks.

Table 5. Summary of NMFS stocks that are strategic because they are listed under the ESA or MMPA. Some of these stocks additionally have incidental mortality greater than PBR (see Table 3 above).

Species	Stock	Listing status
North Atlantic right whale	W.North Atlantic	Endangered
Humpback whale	W.North Atlantic	Endangered
Fin whale	W. North Atlantic	Endangered
Sei whale	W. North Atlantic	Endangered
Blue whale	W.North Atlantic	Endangered
Sperm whale	W.North Atlantic	Endangered
Bottlenose dolphin	W.North Atlantic, coastal	Depleted
Sperm whale	N. Gulf of Mexico	Endangered
Sperm whale	CA/OR/WA	Endangered
Humpback whale	CA/OR/WA-Mexico	Endangered
Blue whale	California/Mexico	Endangered
Fin whale	California/Oregon/Washington	Endangered
Sei whale	Eastern North Pacific	Endangered
Guadalupe fur seal	Mexico/California	Threatened
Blue whale	Hawaii	Endangered
Fin whale	Hawaii	Endangered
Hawaiian monk seal	Hawaii	Endangered
Steller sea lion	Western, U.S.	Threatened
Steller sea lion	Eastern, U.S.	Threatened
Northern fur seal	North Pacific	Depleted
Sperm whale	Alaska	Endangered
Humpback whale	Western North Pacific	Endangered
Humpback whale	Central North Pacific	Endangered
Fin whale	Alaska	Endangered
Northern right whale	North Pacific	Endangered
Bowhead whale	Western Arctic Stock	Endangered

The Hawaiian monk seal is also listed as endangered and is thus strategic. The monk seal population declined because of intentional harvests in the 1800's, and declined again in this century because of other human activities. Recently, incidental mortality has been documented in several fisheries. This mortality is not insignificant, but was probably not responsible for the stock's decline.

A total of 6 large whale stocks from Alaska and the North Pacific are listed as endangered. None of these stocks is known to have significant incidental fisheries mortality. There may be some mortality of humpback whales in Alaska. Any take of northern right whales would be considered significant because of their very low apparent abundance. Steller sea lions are listed as threatened because of population declines that have occurred in part of their range in U.S. waters, in what is considered the western stock. The cause or causes of these declines are not completly understood. Incidental takes in fisheries do not appear to have caused the declines but are not considered insignificant. Northern fur seals are listed as depleted because of a population decline from the 1950's to the 1980's. This decline is also not completely understood but incidental fisheries mortality is considered insignificant.

Other Stocks Designated Strategic

The stocks of dwarf and pygmy sperm whales in the western North Atlantic were both designated strategic on the advice of the Atlantic Scientific Review Group because of stranding data indicating apparent mortality due to the ingestion of plastic bags, and because identification difficulties between the two species prevented the calculation of a separate PBR for either species. Additionally, they may interact with the drift gillnet fishery.

The stocks of dwarf and pygmy sperm whales in the Gulf of Mexico were both also designated strategic because of apparent mortality due to the ingestion of plastic bags, and because identification difficulties between the two species prevented the calculation of a separate PBR for either species. The Gulf of Mexico stock of bottlenose dolphin (in bay, sounds, and estuaries) was designated strategic because it was concluded that in most of the bays and sounds the take of a single animal would exceed that area's individual PBR, and there is documentation of stranded animals with evidence of fisheries entanglement in those areas. Gulf of Mexico short-finned pilot whales were designated strategic because of their low population size and the documentation of fishery-related mortality in the longline fishery.

Table 6. Summary of other NMFS stocks designated strategic. Following the recommendation of the regional Scientific Review Groups, the following stocks have been designated strategic because of potential fisheries interaction problems and a lack of information and/or because of other potential problems with human-caused mortality.

Species/Region	Stock
Dwarf sperm whale	W. North Atlantic
Pygmy sperm whale	W. North Atlantic
Bottlenose dolphin	Gulf of Mexico, Bays, Sounds, and Estuaries
Dwarf sperm whale	N. Gulf of Mexico
Pygmy sperm whale	N. Gulf of Mexico

Problems and Issues in Designating Stocks as Strategic

Several problem areas in designating stocks as strategic were identified. The difficulty of identifying some types of animals to species sometimes makes it difficult to assign abundance or mortality to the appropriate stock. This was especially true for beaked whales, and for the species-pairs of Atlantic/pantropical spotted dolphins, long-finned/short-finned pilot whales, and dwarf/pygmy sperm whales. In general, when the pooled mortality exceeded a PBR calculated from the pooled abundance, all of the involved stocks were declared strategic, as it is certain that at least one of them has its PBR exceeded. For example, the annual mortality of beaked whales in the northeast Atlantic is estimated at 34 animals/year. Although there are 4 species of *Mesoplodon* there that are not easily identified, the greatest available abundance estimate for beaked whales in that area results in a total PBR of only 3.5. Total beaked whale abundance would thus have to be 10 times greater for it to be possible (but not certain) that none of the stocks had their PBR exceeded.

Several stocks with their PBR exceeded by fisheries mortality are known to have abundance estimates that are biased low. However, the magnitude of these biases are unknown. Many of the stocks that are strategic because of mortality in the drift gillnet fisheries for swordfish on both coasts are deep-diving species for which correction factors for time below the surface are not yet available. However, unless such correction factors are estimated to be high relative to correction factors that have previously been calculated for cetaceans, most of these stocks would still be strategic. A field study to attempt to calculate such correction factors has been funded for FY95.

Many of the 15 stocks that are strategic primarily because of mortality in the Atlantic drift gillnet fishery as well as other Atlantic fisheries may additionally have abundance under-estimated because in recent years there has not been a comprehensive abundance survey of the waters of the Atlantic EEZ outside of the Gulf of Maine. Abundance surveys have been done in this area in each of the last 5 years, but in each case only a portion of the area was surveyed. However, these surveys have concentrated on what are thought to be cetacean high-use habitats, so it is not clear how much of an under-estimation problem occurs because of this.

Fully understanding the impact of incidental fisheries mortality is still not possible in many areas because some fisheries known (from logbooks or other sources) or suspected of taking marine mammals either do not have an observer program or have minimal coverage. These include coastal gillnet fisheries in the Atlantic and Gulf of Mexico, the Atlantic mid-water trawl fisheries for mackerel and squid, several salmon gillnet fisheries in Alaska and one in Washington, and possibly some fisheries in Hawaii.

Three Alaska stocks (Gulf of Alaska harbor seals, Norton Sound Beluga, Cook Inlet Beluga) have not had their PBR and status under the MMPA determined because these 3 stocks met the following criteria: (1) they are subject to Alaska Native subsistence harvests, (2) they are not listed under the ESA or MMPA, and (3) their mortality and serious injury incidental to commercial fishing is absent or is a relatively minor contribution to total human-related mortality and injury. Sustainable harvest levels and status determinations for these stocks will be determined from the analysis of information gathered through the Co-management process, and will reflect the degree of uncertainty associated with the information obtained for these stocks.

Other Issues

In most cases, the PBR guidelines (Part III) were found to be sufficient for writing the reports and determining status. However, certain specific cases made it clear that there were several areas that deserved further consideration, and thus the PBR guidelines are not considered fixed or unchangeable at this time. It was found that some case-specific situations sometimes required flexibility to depart from the guidelines. NMFS scientists agreed that flexibility was important and permissible as long as the reason for it was justified and explained in the stock assessment report.

The one area in which there was not complete agreement within NMFS was the use of a correction factor for which there was no estimate of precision (e.g., CV) available. If no CV is available for a correction factor that is used, the estimate of N_{min} is not necessarily conservative, and may not meet the definition of N_{min} provided in the MMPA (e.g., sec. 3 (27) "...(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."). On the other hand, not accounting for a known bias leads to a lower than necessary estimate of N_{min}. Therefore, for some Alaska stocks subject to subsistence harvest, following the advice of the Alaska Scientific Review Group, correction factors for the abundance estimates were used even if CVs were not yet available. One obvious solution to this issue is further research on estimating the precision of correction factors. NMFS is conducting research on correction factors for many such stocks.

The definition of stocks was found to be one of the most difficult issues to resolve. NMFS has received conflicting comments from various constituents, as well as the Scientific Review Groups, about how to define stocks. There was general agreement within the MMPA implementation task force with the approach described in the PBR guidelines, but there was some disagreement in specific cases with the interpretation of that advice. The guidelines recommend that a risk-averse strategy be applied when biological information indicates that there may possibly be more than one stock within an area (e.g., using biologically reasonable smaller groupings where indicated). Biological evidence relevant to stock structure includes distribution and movements, population trends, morphological differences, genotypic differences, contaminant and natural isotope ratios, parasite loads, and oceanographic/habitat differences. Using smaller groupings for stocks does not decrease the total PBR but does ensure that removals, if they occur, are spatially distributed in proportion to abundance. This is seen as a proactive approach that will prevent unexpected depletions that could occur if removals as high as a PBR calculated for an entire region occurred in a much more limited area than the area used to estimate abundance. Further consideration of how best to define stocks in the face of uncertainty is clearly warranted.

Appendix I: Report of the Joint Scientific Review Group Meeting, 12-13 October 1994, Seattle, Washington

This Appendix was prepared by the Office of Protected Species, National Marine Fisheries Service, Silver Spring, Maryland.

The three regional Scientific Review Groups (SRGs) constituted under the 1994 Amendments to the Marine Mammal Protection Act (MMPA) held their first joint meeting 12-13 October 1994 at the Alaska Fisheries Science Center in Seattle, Washington. The purpose of this first joint meeting was to: (1) organize each group; (2) review the advisory role of each group as mandated by the 1994 Amendments; and (3) to review and obtain the groups' comments on the National Marine Fisheries Services' (NMFS) proposed process for calculating Potential Biological Removals (PBRs) for all marine mammal stocks in U.S. waters.

Group Organization

The following Spokesperson were appointed by each group:

Atlantic SRG - Andy Read, Woods Hole Oceanographic Institute
Pacific SRG - John Heyning, Los Angeles Natural History Museum
Alaska SRG - Lloyd Lowry, Alaska Department of Fish and Game

Each SRG agreed to schedule meetings to review the draft stock assessment reports for marine mammals stocks in their region. These meetings will take place as follows:

The Atlantic SRG on 4-6 January 1995 in Woods Hole;
The Alaska SRG on 12-13 December 1994 in Anchorage; and,
The Pacific SRG on 13-15 December 1994 in La Jolla.

The SRG agreed to get comments on the draft reports to the NMFS and the Fish and Wildlife Service (FWS) by mid-January 1995 so that the final Stock Assessment Reports can be completed by late February 1995.

Proposed PBR Process

Scientists from the National Marine Mammal Laboratory and the Southwest Fisheries Science Center prepared and presented background on the development of the PBR process formulated at the PBR workshop held by the NMFS last June in La Jolla, California. Each SRG then met separately to discuss and formulate recommendations on the proposed PBR process. Their individual reports are attached (see Attachments 1-3).

General Comments

All SRGs believed that the proposed PBR process was well founded and reasonably conservative so as to provide minimum risk to marine mammal stocks that are subject to removals by commercial fishing or other causes. Concern was expressed that the process may fail (i.e., identify stocks as strategic when they actually are not) when data are inadequate to determine population abundance. They recommended that, where appropriate, the PBR process should remain flexible so as to be able to consider additional information, including alternatives to abundance estimates such as population indices, on specific stocks in specific regions. Several suggestions were made to further improve the PBR process and these are summarized below.

Stock Identification

The SRGs supported the proposal that stocks should be defined as the smallest units that are supported by genetic and/or other biological evidence, and at minimum, should be defined as the populations within the geographic area in which taking occurs. The SRGs suggested that before either lumping small units or splitting larger units reliable statistical and/or biological information should be required. SRGs noted that reasonable biological evidence could be a sufficient standard in appropriate cases rather than strictly requiring a specified level of statistical power as the single deciding factor for lumping or for splitting stocks.

N_{best}

The SRGs recognized that all population estimates are subject to some degree of uncertainty, and even absolute counts cannot be assumed to include 100% of a population. In this regard, they recommended that species-regional specific correction factors (or multipliers) should be developed for "best" estimates of population size, and that abundance estimates should always include some indication of the portion of the known range of the stock to which the estimate applies.

N_{min}

All the SRGs agreed that the use of 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) for calculation of PBR was well founded scientifically, reflected the uncertainty in the estimation of abundance by being tied to the CV of the estimate, and is appropriately conservative.

5-year Population Phase Out

The original PBR proposal recommended that if population abundance information were 5 years or older, that the population estimate used in the PBR calculation should be reduced 20% (of the initial minimum abundance estimate) per year such that the estimate was zero after five years. The intent here was to ensure that PBR levels are based on recent (reliable) abundance estimates and to encourage assessments of populations on a regular (nor greater than 5 years) schedule.

SRGs believed that the concept of being more conservative where assessment information is old and unreliable was appropriate; however, ratcheting down abundance estimates according to some arbitrary schedule was not scientifically acceptable. SRGs recommended in general that if a ratchet were used, it should apply to the recovery factor rather than the abundance estimate, and it should be based on some rational approach. In an individual session, the Alaska SRG recommended that when abundance estimates are >5 years old, the N_{min} should default to "Unknown" and the corresponding PBR should be "Unknown". If there is a known or suspected fishery mortality that could be biologically significant (i.e., likely to significantly decrease recovery time or maintain a stock below its OSP range), the stock should be strategic. However, if the only human-induced mortality is subsistence harvest which in and of itself may not be biologically significant, another rule should apply. For example, if there is no evidence (including Traditional Environmental Knowledge) that the affected stock is below OSP, then the stock should be designated nonstrategic. If there is evidence that the stock is below OSP, it should be designated strategic.

R_{max}

The PBR proposal suggested that default values for R_{max} of 0.04 for cetaceans and 0.12 for pinnipeds (0.5 x R_{max} = 0.02 and 0.06, respectively) be used to calculate PBRs except when estimates of net productivity based on observations were available.

The SRGs agreed that the defaults were reasonable for populations where no information exists on net productivity, but because different populations of the same species could have different net productivity rates, actual measurements of population trend are preferred. They agreed that additional research should be directed at obtaining observed estimates of population trend for marine mammal stocks of high priority. For populations that are known to be declining, the positive value for R_{max} should be offset by reduction of the Recover Factor (see below).

Recovery Factor

The PBR proposal recommended that the Recovery Factor (F_r) should range from 1.0 for stocks within their Optimal Sustainable Population (OSP) range, to 0.65 for cetacean and 0.50 for pinniped stocks that are below OSP and/or threatened, and 0.1 for endangered stocks. For stocks that are known to be within OSP or known to be increasing in the presence of takes greater than the calculated PBR the F_r could have higher values up to and including 1.0 These values were based on the results of a series of robustness trials that considered plausible bias in the estimates of abundance, mortality and values for one-half R_{max} such that any stock would be maintained within OSP with 95% probability, and that stocks starting at the lower bound of OSP would remain within OSP range after 20 years with 95% probability.

SRG members supported to intent of using the F_r to compensate for uncertainty and possible unknown estimation errors, and to accommodate additional information and allow for management discretion as appropriate and consistent with the goals of the MMPA. However, the SRGs were concerned that the use of fixed values for the F_r could result in major "jumps" in the value of PBR and that this could have drastic effects on commercial fishing and other users. For example, the allowable PBR for threatened Steller sea lions could be reduced by 80% if that stock were listed as endangered without any scientific evidence to support such a reduction in allowable take.

The SRGs recommended that the F_r should be "tuned" to a specific value for each stock based on all available information on that stock and an expanded series of robustness trials. A NMFS scientist explained that additional robustness trials undertaken since the June PBR workshop suggested that the recovery factor for depleted, threatened, or unknown-status cetacean stocks is more appropriately 0.5 rather than 0.65. After some discussion, SRG members agreed that in the absence of evidence to the contrary the default value of 0.5 should be used for cetaceans.

Takes Other Than by Commercial Fisheries

In their initial PBR proposal, NMFS proposed that stocks for which no information on status is available should be classified as "strategic stocks". The SRGs believed that there was no basis for such a determination and recommended that stocks for which there is no status information should not categorically be listed as strategic particularly if those stocks support subsistence takes. If there is a known or suspected fishery mortality, the stock should be strategic, however, if the only human-induced mortality is a subsistence harvest, another rule should apply. For example, if there is no evidence (including Traditional Environmental Knowledge) that the affected stock is below OSP, then the stock should not be designated strategic. If there is evidence that the stock is below OSP, it should be designated strategic. In all cases where stock status is unknown, the SRGs agreed that surveys, or other appropriate biological research programs, should be conducted to evaluate stock status in relation to OSP.

Zero Mortality Rate Goal

The PBR proposal stated that if the total fisheries related mortality was less than a small portion (10%) of the calculated PBR for a stock, the ZMRG would have been achieved. The SRGs could not reach consensus on this definition. Some believed that fisheries related mortality of less than 10% of the PBR would be an insignificant mortality rate. Others believed that while 10% of a small number may be insignificant, 10% of a large number could not be assumed to be negligible. This issue will likely require development of a government policy on criteria for attaining the ZMRG.

Further Research

The SRGs recommended that additional research should be directed at:

(1) The use of alternative population models for calculating PBRs and for robustness trials.

(2) Incorporate stochastic and age/sex variables into the PBR calculations.

(3) Explore the potential effects of presumed single-species harvests on multi-species populations (e.g., beaked whales).

Appendix II: Report of the Atlantic Scientific Review Group Meeting, 12-13 October 1994, Seattle, Washington

Atlantic Review Group members present included: Odell, MacKinnon, Wells, Mead, Harris, Read, Brault, and DeAlteris.

Read was elected spokesperson, with Odell serving as deputy spokesperson. We agreed to meet next in Woods Hole, MA between 04-06 January 1995.

General Comments

Overall, Atlantic SRG members were comfortable with the PBR approach, particularly with the flexibility of recovery factors, for example allowing an increase in the Recovery Factor if stocks are shown to be increasing when the total PBR is being taken.

PBRs are not useful for endangered species or very small populations. Presumably, these will be managed separately under the ESA through recovery plans, etc.

In keeping with the philosophy of the MMPA, we would like to attempt to identify, wherever possible, factors other than direct or indirect takes, such as exploitation of prey stocks, habitat destruction, etc. that might affect the dynamics of these populations.

We need consistency among the SARs in how information is presented. For example, both observed kills and estimated total kills are presented in the current Federal Register notice without distinction. This also pertains to survey data, so that clear specification is given as to how estimates were generated, the type of survey used, type of expansion factor, etc.

N_{min}

Atlantic SRG members found the use of N_{min} to be reasonable and conservative.

In some cases, complete census data are available and these should be used whenever possible.

Correction factors should be applied uniformly and should have associated measures of error. Where no correction factors are available, research should be directed towards obtaining them. Some consideration needs to be given in what constitutes "an updated minimum population estimate." Factors other than CV need to be considered, such as the area covered by the survey and survey methodology used.

Frequent surveys should be conducted for strategic stocks and the use of weighted averages of these time series of estimates could provide more precise and unbiased estimates of abundance.

R_{max}

The default values used in the PBR workshop report were acceptable to the Atlantic SRG. Whenever possible, however, empirical measures of R_{max} should be used in place of these default values. We recommend measuring R_{max} from small or depleted stocks through a series of annual surveys, whenever such an opportunity arises (e.g. depleted population of coastal Tursiops in mid-Atlantic).

Recovery Factors

The default values for cetaceans should be changed, so that 95% of the robustness trial populations achieve OSP within 100 years, for example (three of seven bias trials do not currently achieve this goal).

Robustness Trials

The Atlantic SRG members felt that the results of these trials provided clear evidence of the utility of the PBR approach and the robustness of the model in the face of potential bias and imprecision.

The base model is deterministic and it would be useful to explore the effects of stochasticity on the simulation trials. Stochastic effects could increase the amount of time stocks take to recover to OSP levels or remove stocks from the OSP range (e.g. Tursiops die-offs).

The effect of the shape parameter on recovery time should be explored and possible relationships between this parameter and stochastic effects should be examined.

The effects of age and sex structure on the dynamics of these models should be investigated.

Multiplicative effects should be considered in the formulation of these models. It is difficult to imagine a situation in which all biases are operating in the same direction, but such potential effects should not be overlooked. Currently all biases are evaluated independently.

Zero Mortality Rate Goal

The proposed level (10% of PBR) appears to be arbitrary and is not tied to a well-defined goal or criterion. There was uneasiness among some members of the Atlantic SRG that the use of a biological criterion did not reflect the intent of the Act.

Research needs to be conducted to evaluate what constitutes "an insignificant take approaching zero" in biological terms, perhaps utilizing existing model structures.

The potential exists for important effects on social structure from small numbers of removals from certain social systems. Even limited removals can have important effects on the dynamics of the more social marine mammals (e.g. coastal Tursiops, pilot, killer and sperm whales). Such factors should be considered when evaluating ZMRG.

Stock Structure

In general, the Atlantic SRG agreed with the strategy of using the smallest stock unit possible. This approach seems conservative and safe.

An additional tool for evaluating stock structure (not mentioned in the PBR Workshop report) is knowledge of the ranging patterns of individuals.

Multi-stock problems, which include multispecies complexes (e.g. Mesoplodon, Globicephala) need to be addressed in more detail, including examining the effects of takes of a single species from an abundance estimate generated from several species. Further research is required on the identification of such species at sea and in fishery kills.

Care should be taken when coalescing fine units of stock structure into larger units. Evidence from several sources (e.g. life history, genetics, morphology, behavior) should be required before such units are lumped.

Several stocks occur only at the margin of their range in the U.S. Atlantic EEZ, such as harp and hooded seals and white-beaked dolphins. We believe that U.S. fisheries takes of these stakes may be insignificant at the population level. Estimated PBRs on the proportion of animals in U.S. waters might be problematic (especially if estimates of cumulative stock and takes are not available over the entire range of the population).

This issue needs substantially more discussion from various interest groups, perhaps in the form of a workshop.

Appendix III: Report of the Alaska Scientific Review Group Meeting, 12-13 October 1994, Seattle, Washington

Members present: Jim Branson, Joe Blum, Carl Hild, Sue Hills, Brendan Kelly, Denby Lloyd, Lloyd Lowry, Elizabeth Mathews, Caleb Pungowiyi (12 October only), Jan Straley, and Kate Wynne.

All those who had been asked by the National Marine Fisheries Service to be members of the Alaska Regional Scientific Review Group (SRG) were present. Caleb Pungowiyi explained that he would not be able to attend the second day of the meeting because he had to give a presentation at the Alaska Federation of Natives meeting in Anchorage. The SRG appointed Lloyd Lowry to act as chairman (spokesperson) by unanimous consent.

The group understood that the principal reasons NMFS called the meeting were to get recommendations from the SRGs on the methods that had been used to calculate Potential Biological Removal (PBR) levels for marine mammals stocks in the draft Stock Assessment Reports (SARs), and for the SRGs to decide how they will provide detailed review of the draft SARs. The Alaska SRG also included assessment of human takes and methods for designating strategic stocks in their discussions.

The SRG discussed each of the components of the PBR calculations and how they were used in the SARs. It was recognized that in some cases the approach used was tightly constrained by language provided in the 1994 amendments to the Marine Mammal Protection Act (MMPA), while in other cases MMPA language provided NMFS with substantial flexibility. To the extent possible, the group restricted its recommendations to areas where NMFS had latitude, but there was some discussion about problems that could result from inflexibility in interpretations of the law. With regard to the latter point, the group noted that there are a number of Alaskan species for which there is no evidence of significant conservation problems, and for which it would be very difficult (and expensive) to collect all the data necessary to do a strict numerical assessment of PBR relative to human takes. It would be inadvisable to divert funding from known conservation problems to situations of this type solely to gather data to prove that stocks are non-strategic using the PBR methods.

Stock Identification

The SRG agreed with the need for management to be based on stock units that are meaningful genetically and in relation to areas where takes are occurring. They were unsure that the policy described in the PBR, which required relatively little evidence for splitting stocks but statistically significant evidence for lumping, was entirely appropriate. The SRG recommended that wherever possible statistical testing (including considerations of statistical power) should be used both for lumping and splitting of stocks. When stock divisions are based principally on the area of takes, consideration should be given to the resolution of available information on areas of take in relation to known or suspected genetic isolation. The group noted that the policy described in the PBR report and its references was not applied uniformly to Alaska species in the draft SARs, and it was decided that further comments on the stock identity issue would be made during the review of the individual SARs.

N_{best}

The group discussed several issues relating to estimation of population size. First it was felt that the "best estimate" of population size should attempt to account for all of the animals actually in the population. The need to be conservative should be taken care of in calculation of N_{min} or by application of a recovery factor. There was concern that in many cases what was being presented in SARs as N_{best} is actually a very substantial underestimate. One significant source of underestimation is the failure to account for animals that are not visible (i.e., underwater or not on haulouts) during counts or surveys. The SRG recommended that where possible correction factors should be applied to adjust population estimates and reduce this negative bias.

While it would be ideal to be able to use survey specific correction factors (and associated CVs), the group thought that if such data were not available other relevant information (e.g., studies of the same species at a comparable haulout and during comparable seasons) should be evaluated and used if appropriate. Similarly, if survey or count data do not cover the entire range of the stock, extrapolations to estimate numbers likely to occur in uncounted areas would be appropriate. Where it is not possible to develop a numerical estimate of the number of animals missed during surveys, the SARs should provide a discussion of the adequacy of the data and some indication of the degree by which N_{best} underestimates the actual population size.

The group discussed the recommendation in the PBR report that after five years without a population estimate the value of N_{best} used to calculate PBR should be reduced by 20% per year. While it was evident that this could provide powerful incentive for producing population estimates at intervals of less than every five years, the group agreed that there was no scientific basis for taking such an approach. While there have been some relatively rapid stock declines documented for marine mammals, the likelihood of a stock's abundance actually declining to zero over such a time frame is very remote. Stocks might also stay stable or increase over periods of 5-10 years. Furthermore, applying such a policy would force NMFS to produce total population estimates for a great number of stocks for the sole purpose of being able to calculate a PBR. In many cases, attempting to estimate total population size at regular intervals is likely to be a very expensive and inefficient way to monitor population status.

The group made two recommendations on how to deal with situations where the data on population size is or becomes too old to be entirely reliable. In cases where no population estimate has been produced in the past 10 years (or the data that has been collected is obviously insufficient to estimate N_{best}), previously published population estimates should be reviewed and summarized in the SARs.

The N_{best} for those stocks should be indicated as not available. In cases where recent population size estimates are available, NMFS should either repeat surveys at intervals of five years or less, or implement a program that will allow for monitoring of population status/trend (e.g., using counts at selected sites, sampling of biological parameters, information collected from subsistence hunters, etc.). If five years after the initial survey there has not been another adequate survey, or trend monitoring sufficient to show that the population has either stayed stable or increased, then the N_{best} for that stock should be considered as not available.

N_{min}

The SRG agreed that the PBR workshop recommendation to use the 20th percentile of the distribution of estimates of N_{best} was appropriate, and satisfies MMPA guidance to be conservative in the estimation of population size.

R_{max}

The group agreed that in many cases it would be necessary to use default values to estimate the maximum reproductive rate for stocks, and that the default values proposed in the PBR report should suffice for most pinnipeds and cetaceans. However, some Alaskan species (e.g., polar bear, walrus, and sea otters) have life history traits that may make use of default values inappropriate. In that regard, the proposed requirement to prove that an empirically derived measurement for a particular stock differs significantly from the default could be inappropriate and prevent use of the best scientific data available. The SRG recommended that stock-specific estimates of R_{max} should be used where they are derived from adequate scientific research programs (e.g., published in peer-reviewed articles or accepted by review groups such as the Scientific Committee of the International Whaling Commission).

Recovery Factors

The SRG recognized that use of recovery factors is an area where NMFS was given considerable latitude in the MMPA amendments. The group thought that the proposed recovery factors for stocks within OSP (1.0); stocks declared depleted, threatened, or of unknown status (0.5); and endangered stocks (0.1) were generally reasonable. However, the official listing status of a stock may not in all cases adequately reflect its population status and the degree of threat that it faces. The SRG recommended that NMFS maintain some latitude to modify F_r based on explicit information about particular stocks, and not institute a system in which the only option for change is an abrupt switch in categories.

Takes by Humans

The Alaska SRG recognized the unique situation in Alaska where marine mammal stocks are subject to both taking by fisheries and taking for subsistence by Alaska Natives. Concern was expressed that the SARs focussed only on those direct takes and gave little or no attention to other possible human impacts such as habitat degradation. The group thought that the data given on fishery takes in the SARs was not sufficient to assess the likely magnitude of taking, and they requested a more complete presentation of which fisheries were likely to take from each stock, whether those fisheries had been subject to logbook or observer programs, and what take and effort data had been collected on takes in observed/logbook fisheries. With regard to collecting data on fishery takes, the group recommended that when NMFS prepares to modify the current lists of fisheries that take mammals the draft and final regulatory proposals should go through the consultative process with the SRGs.

Zero Mortality Rate Goal

The SRG discussed the PBR report proposal for evaluating whether or not the Zero Mortality Rate Goal (ZMRG) has been met. The group agreed that the NMFS proposal is reasonable as it defines a rate of taking that is biologically insignificant in that it is very unlikely to deplete an OSP stock or to significantly impede recovery of a depleted stock. For assessing takes in relation to the ZMRG or PBR, the group recommended that recent data (i.e., an average over the past five years) should be used, but recognized that this might need to be modified based on stock-specific considerations.

Identification of Strategic Stocks

The group understood that when stocks are officially listed as endangered, threatened, or depleted NMFS has no option other than to classify them as strategic. For all other stocks NMFS has some latitude depending on how they assess whether the stock meets the definition of non-strategic given in section 117(a)(5)(A) (i.e., "has a level of human-caused mortality and serious injury that is not likely to cause the stock to be reduced below its optimum sustainable population"). This is particularly an issue for stocks where old data indicate that populations are quite large and the only taking has been a moderate level of subsistence harvest.

The group felt very strongly that it is inappropriate to use a PBR approach that incorporates obviously incorrect data and assumptions and arrive at the conclusion that such a stock is "strategic." They recommended that stocks for which there is no significant fisheries take and that are taken principally for subsistence should be classified as non-strategic unless there is some reason to think that the stock is below OSP or will decline to below OSP. A variety of sources of information (e.g., trends in catch rates and biological parameters measured from harvested animals) could be evaluated to assess whether or not recent takes are likely to have had any impact on stock size or status. If the PBR method is used to categorize stocks used primarily for subsistence as strategic, then funding should be provided to gather adequate data on population size and take levels.

Conclusions

The Alaska SRG felt that NMFS has generally done a good job of defining parameters involved in calculating PBR, and in compiling and presenting information in the stock assessments that were released for public review. However, the group thought that for their purposes the SARs should be more complete and detailed, especially in the sections that describe and evaluate data on population sizes and fishery takes.

The SRG thought that the PBR method for assessing stocks is straightforward when good data are available on population abundance and takes by humans, and that it is probably an appropriate technique to use in those cases. However for many Alaskan stocks, comparing PBR to human takes is not the best method to use. For some stocks no new data were collected during the 1988-1993 interim exemption period, and collecting the data necessary for PBR calculations in the future would be very difficult and expensive. In some cases it will be virtually impossible to gather the data necessary for accurately estimating total population size, and alternative indices will have to be pursued. NMFS needs to maintain the flexibility to use a variety of methods for evaluating and monitoring status of stocks in Alaska.

The Alaska SRG felt strongly that the intent of Congress in designing sections 117 and 118 of the MMPA was to institute a regime for identifying situations where commercial fishing is having an impact on marine mammal populations, and to provide a mechanism for reducing fishery takes in those situations. Because in Alaska marine mammals are an important subsistence resource, and because little research has been done recently on some of the subsistence-harvested species, a number of Alaskan stocks have been inappropriately proposed to have a strategic designation. NMFS needs to adapt the process it is using to evaluate non-strategic versus strategic stocks in order to clearly focus attention on situations where marine mammal populations are having problems due to interactions with commercial fisheries.

The Alaska SRG agreed to hold a meeting on 12-13 December 1994 in Anchorage to conduct detailed reviews of the Stock Assessment Reports for Alaska species. Individual SRG members volunteered to begin gathering and evaluating the data available for specific stocks in order to facilitate the SAR review at the meeting.

Appendix IV: Report of the Pacific Scientific Review Group Meeting, 12-13 October 1994, Seattle, Washington

In general, the Pacific SRG supported the PBR concept. The defaults are conservative, yet the scheme is flexible enough that it provides the incentive for cooperation between industry and government to collect better information. The SRG offered the following comments and suggestions for further analyses to support the concept.

Mortality Estimates

The group recommended that NMFS test the robustness of the model when the assumption that mortality estimates are collected annually is violated. Given the large amount of resources required for surveys and observer programs, the group was concerned that not all fisheries may be monitored annually. The group wanted to emphasize the importance of well-designed observer programs and recommended that the design of the observer programs be reviewed by the SRGs.

Recovery Factors

The group stressed the need to establish guidelines for changing the F_r from the default settings in a consistent manner. Three situations were recommended for inclusion into the model:

(1) Allowing the F_r to be adjusted for age- or sex-bias of the take to prevent damage to the population due to over-harvesting of females or of reproductively and socially mature animals. [During the plenary session, Dr. DeMaster pointed out that it would be easy to account for sex bias in the management scheme by establishing 0.5 x PBR as an additional limit to the number of females that could be taken. He argued that accounting for age-class bias is much more difficult to incorporate into the model. Recognizing that not every potential bias can be solved by the PBR model, it still should be recognized that populations may contain certain classes of animals whose removal may harm the population out of proportion to their numbers. Where appropriate, such factors should be incorporated into management schemes.]

(2) Because the F_r is designed to provide a margin of safety when the mortality estimate may be underestimated, the group suggested that F_r be increased when the mortality is known with more certainty. This would provide an additional incentive for industries to participate in, and perhaps help fund, government observer programs. Some parameters that could be used as criteria are the percentages of observer coverage for the fisheries involved, or the CV of the mortality estimate when the effort is known with certainty.

(3) When population growth is in excess of that predicted by the model, the F_r could be adjusted accordingly .

"Aging" of Abundance Estimates:

The group supported the idea that abundance estimates become less reliable with age, and that a correction factor should be incorporated into the model. The group was concerned at the arbitrariness of the proposed discounting of N_{min} by 20% annually after survey data are five years old. The group suggested that NMFS explore other correction factors that could have a more biological basis. One suggestion was to use the maximum rate of decline observed over a five-year period for a marine mammal as an indication of how much a five-year-old estimate could be in error if the population was decreasing in numbers.

The group suggested that NMFS consider similar discounting of mortality estimates that are not current as well.

Zero Mortality Rate Goal

The group suggested that the 0.1 * PBR default could be retained as a conservative default for the ZMRG, recognizing that this is an attempt to define a mortality rate that is biologically insignificant rather than numerically insignificant. Others will likely disagree with this approach, arguing that the "approaching zero mortality rate" and "small numbers" terms used by Congress meant approaching absolute zero. Given the vagueness of the language in the MMPA, however, the SRG accepted the working definition of the PBR Workshop for the ZMRG.

Stock Definition

The group agreed with the proposed approach for defining stocks. It was cautioned against splitting stocks too finely such that the surveys would produce abundance estimates with high CVs.

Treaty Rights

The Pacific group will be dealing issues arising from the treaty rights of Northwest Indian tribes. Most of the members of the group do not have the background to evaluate the legal basis for the treaty rights to hunt marine mammals. The extent of these treaty rights and the potential for a native non-subsistence take for commercial sale should be evaluated and summarized for the group by the NMFS or appropriate agency.

General Comments

The group was concerned about how human-caused mortality from causes other than fisheries would be incorporated into the PBR (e.g. oil spills). A mechanism for subtracting such mortality from the PBR should be considered.

The group suggested that stock assessments for endangered species include a statement in the section on PBR that the take may not be as high as the PBR because the Endangered Species Act would likely take precedence over the MMPA.

The group was also concerned about distinguishing natural declines in the population, due, for example, to El Niño events or overshooting the carrying capacity, from human-related causes that would normally trigger action by the NMFS. Of particular concern was that surveys may coincide with short-term natural mortality events and that the PBR would perhaps be affected for several years until the next survey.

It was recommended that NMFS appoint a liaison that would monitor the discussions of all of the SRGs to promote consistency amongst the groups. The liaison could also attend each group's meetings so that all groups could be aware of the activities and decisions of the others. This would be particularly useful for groups that will be reviewing assessments of the same species.

The Pacific SRG agreed to hold its next meeting 13-15 December 1994 in La Jolla, California.