Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington

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This document summarizes the discussion and recommendations of a workshop held in April 1996 to review the guidelines being used to assess marine mammal populations as required by the Marine Mammal Protection Act. Included in this document is a copy of the final revised guidelines that resulted from the recommendations of the workshop.

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The GAMMS Workshop
April 3-5, 1996
Seattle, WA

gam

(gam), n., v., **gammed, gam·ming.** — n. 1. A herd or school of whales. 2. *Eastern New Eng. Naut.* a social meeting, visit, etc., as between whaling vessels at sea. —v.i. 3. (Of whales) to assemble into a herd or school. 4. *Naut.* (of the officers and crews of two whaling vessels) to visit or converse with one another for social purposes. 5. Eastern New Eng. To participate in a gam or social visit.

1.0 Introduction

1.1 Background

The new section 117 of the Marine Mammal Protection Act as amended in 1994 (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.

The MMPA requires that each Stock Assessment Report (SAR) 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 number of vessels actively participating in the fishery and the level of incidental mortality and serious injury of the stock by each fishery on an annual basis, and an analysis stating whether the level is insignificant and is approaching a zero mortality and serious injury rate; (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.

A primary goal of the MMPA is to prevent any marine mammal stock from being reduced below its optimum sustainable population level, and to restore stocks that have been reduced below that level. A stock which has a level of human-caused mortality that is likely to cause the stock to be reduced or kept below its optimum sustainable population should be classified as "strategic". A marine mammal stock is considered 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, 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. The consequences of being designated strategic include the formation of a take reduction team for each strategic stock which interacts with a category I or II fishery. These teams are required to develop a take reduction plan for each strategic stock, with an immediate goal of reducing the incidental mortality and serious injury to levels less than the PBR.

Section 117 also requires the formation of three independent regional Scientific Review Groups (SRGs) representing Alaska, the Pacific Coast (including Hawaii), and the Atlantic Coast (including the Gulf of Mexico). The Secretary of Commerce established the groups after consulting with the Secretary of the Interior, the Marine Mammal Commission, Governors of affected adjacent coastal States, regional fishery and wildlife management authorities, Alaska Native organizations, Indian tribes, and fishing industry and environmental groups. Members of the groups must have expertise in marine mammal biology and ecology, populations dynamics and modeling, commercial fishing technology and practices, or marine mammal stocks taken under MMPA section 101(b). These groups advise the Secretary on stock assessments, uncertainties and research needed on stocks, impacts to stocks, and methods to reduce incidental mortality in fishing operations.

Immediately after the amendments were signed into law on 30 April, 1994, NMFS and FWS held a workshop on 27-29 June at the Southwest Fisheries Science Center in La Jolla, CA, to draft guidelines for preparing the SARs (called the PBR guidelines). NMFS completed the draft SARs, including preliminary consultation with the three regional SRGs, and made the draft guidelines and the draft SARs available for public review and comment on 9 August, 1994 (59 FR 40527). The three SRGs held their first meetings jointly on 12-13 October, in Seattle, WA, along with NMFS and FWS personnel. The primary focus of that first meeting was to provide the agencies with comments and recommendations regarding the draft PBR guidelines. The public comment period on the draft SARs ended on 1 December, and these comments were compiled, summarized, and distributed to field offices and the SRGs for review in late December.

From December 1994, to February 1995, NMFS consulted extensively with the SRGs to discuss the review groups' and public's comments on the PBR guidelines and the individual draft SARs. The draft guidelines and SARs were modified in response to comments from the SRGs, the public (including non-governmental organizations such as the Humane Society of the U.S., the Center for Marine Conservation, and several Alaska Native organizations), and the Marine Mammal Commission. After discussions by NMFS scientists nationally, particularly authors of the SARs and members of the MMPA implementation task force, the PBR guidelines were finalized near the end of February, 1995.

The revised SARs were submitted to NMFS headquarters in March 1995. These draft final reports were reviewed by NMFS headquarters staff from April to June, with a particular focus on ensuring that the PBR guidelines were consistently applied in all the reports. Additionally, the reports were sent to the regional SRGs for a final review. Some of the comments resulting from these reviews were incorporated into the final SARs, and NMFS published a notice of the availability of the final stock assessment reports and the final PBR guidelines in the Federal Register on 25 August 1995 (60 FR 44308).

Between July and September, the 1995 marine mammal stock assessments and related information were published in the NOAA Technical Memorandum series. Three of those documents contained the final SARs prepared by NMFS in each of 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.* 1995a). The fourth document contained the final PBR guidelines, a summary of the 1995 stock assessments, and the reports of the June 1994 PBR workshop and the October 1994 Joint Scientific Review Group (Barlow *et al.* 1995b).

Concurrent with the development of the draft and final SARs, NMFS developed proposed and final regulations implementing section 118 of the MMPA (60 FR 31666; 60 FR 45086). These regulations allow U.S. commercial fisheries to unintentionally seriously injure and kill marine mammals provided that the fishers comply with certain provisions of the MMPA. The List of Fisheries, which NMFS must publish at least annually, classifies fisheries into one of three categories based on the level of marine mammal incidental serious injury and mortality relative to the PBR level. Those fisheries with frequent or occasional incidental mortality and serious injury levels of marine mammals are placed in Category I or II, are subject to the registration requirements of the MMPA, and must carry an observer if requested by NMFS. Furthermore, fisheries with frequent or occasional incidental mortality and serious injury of strategic stocks may be subjected to regulations which are recommended by Take Reduction Teams or are otherwise determined necessary by NMFS or FWS. Thus, the stock-specific incidental mortality information provided in the SARs, along with the PBR calculations, may have direct impacts on the management of marine mammal incidental mortality and serious injury in commercial fisheries.

After the completion of the 1995 SARs and the recognition that the science provided in the SARs has direct management implications, NMFS recognized that a second workshop would be useful to review the work done and set the course for the future. The MMPA gives specific rules regarding the review and revision of stock assessment reports. Therefore, it was necessary to establish some guidance for how the review and revision process will occur every year. Additionally, it was appropriate to review the 1995 final PBR guidelines to discuss possible improvements that could be made after the experience of preparing the 1995 reports. NMFS also wished to discuss in an open forum whether the structure and content of the information presented in the SARs could be modified slightly to reduce the amount of interpretation needed when making management recommendations.

Therefore, a second workshop for April 1996 was planned. The focus of the workshop was to be potential modifications to the PBR guidelines, as well as the drafting, for the first time, of guidelines for the annual process of reviewing, revising, and producing the SARs. This document reports the findings of that workshop.

2.0 GAMMS workshop goals

The following were the stated goals established prior to the start of the workshop:

- Review stock assessment related processes and other relevant sections of the MMPA
  - the proposed rule defining the Zero Mortality Rate Goal
  - the final List of Fisheries and classification scheme
  - strategic stocks: brief review of what is happening with Take Reduction Teams

- Review and discuss ways of defining stocks for management under the MMPA

  The workshop will spend considerable time reviewing the types of information that are relevant to defining stocks, to review what type of stock structures are to be expected, and to hold some discussion regarding the process by which stocks are defined. It may be useful to attempt to come to a consensus regarding how stocks should be defined for the stock assessments, going into more detail than is currently in the guidelines.

- Proposed additions and revisions to the guidelines for preparing stock assessment reports.

  Discussion of proposed additions and revisions are aimed at providing clearer guidance on particular parts of the SARs. Writing down specific guidelines can help ensure that these sections of the SARs are done in a consistent way nationally, and should also make the jobs of the SAR authors and the PBR table coordinator easier. The objective at the workshop will be to finalize these written sections which describe how to include the necessary information in the SARs. Areas to discuss include:

  - Guidelines for combining abundance and mortality estimates from different years.
  - Table for fisheries mortality information.
  - Use of old abundance estimates.
  - "Definition of Stocks" section
  - Information on habitat, the descriptions of fisheries and the geographical range of stocks.
  - Definition of "mortality and serious injury".
  - Multiple species/stock complexes (such as beaked whales)
  - Declining populations.
  - Recovery factors for endangered whales
  - Correction factors for abundance estimates.

- Guidelines for the annual stock assessment process

  Although guidelines for preparing the stock assessment reports have previously been completed, there are several issues that have to be addressed regarding the stock assessment process and how it will work from year to year. There are some specific issues that will require guidelines, and it is probably appropriate to draft guidelines for the entire process (the report guidelines can be viewed as one aspect of the guidelines for the entire process). Proposed items for the stock assessment process:

- Annual schedule for the stock assessment process
- Revision rules.
- Publication details.
- Availability of reports on which the SARs are based.
- Recommendations for frequency of monitoring, both abundance and mortality.
- Scientific Review Group role.

3.0 GAMMS workshop description

The workshop to review the Guidelines for Assessing Marine Mammal Stocks (GAMMS) was held April 3-5, 1996, in Seattle, WA. The workshop started with a review of elements of the MMPA that are related to the stock assessment process. This included items legislated in the MMPA, and proposed and final rules that NMFS has written to implement the MMPA. These items are summarized in Appendix I.

Several major areas of discussion were held at the workshop related to preparing the marine mammal stock assessments. These included defining stocks (4.0), the calculation and reporting of human-caused mortality (5.0), habitat issues (6.0), classifying stocks as strategic (7.0), calculating PBR (8.0), and reviewing, revising, and publishing the stock assessment reports (9.0). Recommendations made by the workshop participants were incorporated into the revised PBR guidelines (Appendix II).

Also discussed at the workshop were other MMPA items that are directly affected by the results of the stock assessment reports. These included the List of Fisheries (10.0), take reduction plans (11.0), and the zero mortality rate goal (12.0). The perspective and role of the MMPA-established Scientific Review Groups was also discussed (13.0).

The workshop agenda is reproduced in Appendix III. The documents used by the workshop are listed in Appendix IV. The workshop participants are listed in Appendix V. The report of a working group on the definition of mortality and serious injury is listed in Appendix VI. Other items tabled at the workshop are also presented in appendices. This includes a proposed plan defining the role of the Scientific Review Groups (Appendix VII), a proposed annual schedule for reviewing and revising the stock assessment reports (Appendix VIII), and, finally, a summary of statistical background and formula that are used in preparing the stock assessments (Appendix IX).

4.0 Defining stocks for management under the MMPA

The workshop discussions started with several presentations related to the issue of defining stocks for management under the MMPA.

The workshop participants recognized that there are many different ways to define stocks. The appropriate stock definition depends upon the management goal. It was therefore recognized that a stock is a management unit, and does not necessarily have an exact definition in the real world divorced from a management goal. Populations in the real world exhibit a broad continuum of various levels of differentiation, making it difficult to choose a single universal definition of a biological stock that will be meaningful for all species and populations. Stocks are often defined as a unit that will preserve genetic diversity, but there are other possible definitions. Under the MMPA there is a clear mandate to maintain populations as a functioning element of the ecosystem, but there is no language to suggest that distinct genetic units should be the management unit.

4.1 Defining a stock

Dizon gave a presentation of the general principles and information used to identify stocks, and then gave a description of how inferences about stock structure can be drawn from genetic data. Under the U.S. Endangered Species Act, management is by "distinct population segment", which has been defined to be what is called an evolutionarily significant unit (ESU). ESUs must show a degree of isolation, be different and unique, and are intended to represent an evolutionary legacy.

The management goals of the MMPA are different in several ways from the goals of the ESA. The workshop participants re-visited the language of the MMPA with respect to what it implies about the definition of stocks for management under the MMPA. The MMPA states in Section 3(11):

> "The term 'population stock' or 'stock' means a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature."

This definition does not imply that a stock under the MMPA must represent an ESU. The phrase "that interbreed when mature" does not provide an exact definition, but does seem to imply something close to panmixia. However, one might also conclude that if a single animal emigrated only once every 100 years between two adjacent spatial areas, these two populations could be considered to be interbreeding, in a different sense.

Additional guidance is provided in the major goals of the MMPA (Section 2.2):

> Marine mammals "...should not be permitted to diminish beyond the point at which they cease to be a significant functioning element in the ecosystem of which they are a part, and, consistent with this major objective, they should not be permitted to diminish below their optimum sustainable population."

The latter goal has been defined to mean maintaining populations above their maximum net productivity level (50 C.F.R. 216.3), often taken to be a population level between 50-70% of a known historical abundance level. However, if the maximum net productivity level was thought to be 50% of K, a population could decline to one-half of its initial population size and still be at their optimum sustainable population level, but if it was extirpated from one-half of its range, it could not be considered a significant functioning element in the ecosystem in that portion of its range. Therefore, to define stocks to meet MMPA goals, one has to consider the demographic linkages between geographic areas, as well as the genetic linkages. Abundant populations with low levels of mixing (a few animals per year) may be genetically indistinguishable, but the level of mixing may not be sufficient to support the amount of human-caused mortality that occurs in one of the sub-populations. Thus, genetics alone may not provide sufficient data on which to base stock definitions to be assured of meeting management goals.

Many types of data can provide information on stock structure, including distribution, population response, morphology, genetics, life history, and contaminants. Distribution and abundance data can give an indication of stock structure, such as high density areas separated by lower density areas. Different population responses (e.g., different trends in abundance) between geographic regions is an indicator of stock structure, as populations with different trends are not strongly linked demographically.

Geographical differences in genetic or morphological data are strong indicators of stock structure. Concordance of genetic differences with geographic distribution infers isolation, and indicates that separate stocks are appropriate. Fixed genetic differences that are concordant with geographic distribution infers strong isolation (i.e., the next step is speciation).

Current techniques allow sequencing information from almost any type of tissue. Microsatellite data may often be a more powerful tool than mitochondrial DNA.

An example shows the utility of current genetic techniques. Taxonomists have suggested that there were two types of bottlenose dolphin in the Atlantic and perhaps in the Gulf of Mexico: an inshore type and an offshore type. Recent mitochondrial DNA studies found fixed haplotypic differences between inshore and offshore animals in both the Atlantic and Gulf of Mexico. The data strongly support managing different inshore and offshore stocks in both locations. Offshore animals were more similar genetically to offshore animals in the Indian ocean than they were to adjacent inshore animals. Genetic differences were also found between inshore animals in the Atlantic versus those in the Gulf of Mexico. Microsatellite DNA may be of use for further investigation into possible stock divisions within the inshore animals.

4.2 Known stock structure of marine mammals

Heyning provided an overview of what is known about marine mammal stock structure. The perspective of reviewing known information can provide guidance on what stock structure to expect for populations with little information currently available. For many marine mammal populations few data are available that can provide information about stock structure. One consistent trend is that as more information is collected, finer structure within populations has usually been seen. Unique units are often found within populations. Some species have particularly complicated stock structures, such as killer whales and sperm whales. For species with information available, stock structure has virtually always been found to be on a scale much less than that of an entire ocean, such as the Pacific. This is true for small cetaceans (summarized in Perrin and Brownell 1994), is probably also true for large cetaceans, and is true for many pinniped species (it was noted that northern elephant seals, which show little genetic variability, are an exception which may be anomalous because their population was recently reduced to extremely low numbers).

4.3 Consequences of incorrect stock decisions

The key difficulty in defining management stocks has been whether a manager should lump or split adjacent populations. This is a particularly difficult and important decision when incidental fisheries mortality is concentrated in just one of the areas.

Taylor demonstrated an interactive computer simulation (RISK) designed to illustrate the pitfalls of inappropriate stock definition. The program assumes that two stocks are inappropriately managed as a single stock. Although the user can input any scenario, four examples are provided to demonstrate specific points and Taylor went through these with the group. The program graphically shows the resulting population trajectories and the user can then change input to the program (such as the amount of dispersal between stocks) and view the resulting change. The first lesson is that inappropriate pooling can lead to overestimation of the abundance of animals available for "harvest". This can lead to depletion or elimination of the stock experiencing the high mortality. The user can then "find" (by entering different values) the dispersal rate which would meet management objectives. This critical dispersal rate is what would be required before a single stock definition would provide satisfactory results and would be the amount of mixing that geneticists would seek to find in stock definition studies. Other lessons demonstrated in the program are: 1) if there is unrecognized stock structure, then the level of the current population relative to historical numbers is important, 2) the type of mortality is important to the dynamics, where the types are mortality incidental to fishing operations (assumed to be a constant proportion of the population) and directed take (assumed to be a relatively fixed number of animals), and 3) in the case where a large population is exploited next to a small population, dispersal is always to the detriment of the small population.

In situations where managers must decide between lumping or splitting adjacent areas, the most important information to know is the number of animals moving between areas in each year. Unfortunately, this is very difficult information to collect. Monitoring the movement of individual animals is often difficult and impractical. Identifying genetic or morphological differences between areas will usually be strong evidence that animals do not move between areas in sufficient numbers to prevent the extirpation of one of these populations. However, the movement of small numbers of individuals between the populations could prevent any genetic or morphological differences, yet might still be insufficient to prevent the decline and extirpation of one of the populations. Therefore, one cannot conclude that one stock is the appropriate management unit based only on a lack of detection of genetic differences. Furthermore, the statistical power to detect a difference also needs to be considered to correctly interpret an observed lack of difference between two areas.

It is recognized that in principle one should be able to relate dispersal rate to some sort of genetic measure. Actual estimation of dispersal rates from genetic data is difficult and requires that certain assumptions be made that are difficult to test. As dispersal increases genetic differentiation decreases. However, when abundance increases genetic differentiation will also decrease. In the situation where large populations have very little annual dispersal, finding significant differences will be very difficult. This difficulty arises because there are few genetic differences between populations, which makes finding these differences problematic. For example, Alaska harbor seals are so abundant that a dispersal rate of only about 10 animals per year between areas, which is a small number relative to the total population size, would make it difficult for genetic data to show population distinctness.

Table 1 is provided to attempt to capture the important consequences of the above discussion by illustrating what the expected genetic and demographic distinctness will be between large populations and between small populations at different rates of dispersal between the populations. The important points can be summarized as follows. At very low ("rare") dispersal rates, one expects the populations to be both genetically and demographically distinct, and should thus be managed separately. At high dispersal rates, one expects the populations to be neither genetically nor demographically distinct, and should thus be managed as one unit. However, for either a scenario with large or small populations, there is a possible rate of dispersal that would be great enough to eliminate genetic differences between populations, but would not be sufficiently high to prevent the populations from being demographically distinct. The final point is that at some level of a low rate of dispersal, the genetic differences between two large populations will be eliminated but would not be between two small populations. The workshop participants agreed that it would be useful to have further discussion on the definition of stocks, and consider revisions to the guidance given in the PBR guidelines. This discussion can be found in section 4.5.

4.4 Biological data important to management

Chivers summarized the type of biological data that are available and its importance to management. Fisheries observer programs, in addition to providing data from which to estimate mortality, also provide the largest source of tissue for genetic analyses. Furthermore, tissue samples can be used to identify species and stocks which can be difficult to identify when visually inspecting incidental catches in fishing gear at sea. Therefore, Chivers stressed that it is important to attempt to sample as many specimens as possible, which has been accomplished in some observer programs. For example, since 1994 about 90% of the observed kills in the CA drift gillnet fishery have been sampled. The genetics archive at the SWFSC in La Jolla currently has 4918 specimens representing 62 species of cetaceans and 7 species of pinnipeds. Reference to genetic sequences of voucher specimens allows the identification of species from small tissue samples.

Observers have had difficulty identifying some cetaceans, such as the two forms of Delphinus (long and short beaked) and beaked whale species. It is not satisfactory to assess fisheries mortality for a multi-species group rather than for individual stocks, but the agency has been forced to do so currently for beaked whales, for example. Therefore, it is particularly important that observer programs acquire tissues samples from difficult to identify species.

Table 1. A conceptual presentation of the expected genetic and demographic differences between sub-populations for different levels of dispersal of individuals between the sub-populations. The rates of dispersal have been defined specifically to illustrate several points, and note that they are relative terms only, as even the category of "high dispersal" may still represent only a few percent of the population per year. "Rare to no dispersal" is defined to be a level of dispersal that is low enough that genetic differences will be expected for any size of populations. "Low dispersal" is defined to be a rate of dispersal that is just sufficient to eliminate any genetic differences between two large sub-populations. "Moderate dispersal' is defined to be a rate of exchange that is just sufficient to eliminate any genetic differences between two small sub-populations. "High dispersal" is defined to be a rate of dispersal that is just sufficient to eliminate any demographic differences between two sub-populations. Finally, note that whether the sub-populations should be split for management or not is directly linked to whether they are demographically distinct or not. "Demographically distinct" is defined to mean that the exchange of individuals between the populations is not great enough to prevent the depletion of one of the populations when it experiences human-caused mortality that would certainly cause depletion if there was no exchange.

	Can a genetic difference be detected?	**Are the sub-populations demographically distinct?**	**Should the sub-populations be split for MMPA management?**
Large sub-populations			
rare to no dispersal	yes	yes	yes
low dispersal	no	yes	yes
moderate dispersal	no	yes	yes
high dispersal	no	no	no
Small sub-populations			
rare to no dispersal	yes	yes	yes
low dispersal	yes	yes	yes
moderate dispersal	no	yes	yes
high dispersal	no	no	no

4.5 Discussion on the definition of stocks

In general, the workshop participants agreed with the points made by the presenters. However, some of the participants pointed out that it was still unsatisfactory that there was no completely objective method for choosing a specific stock area in the face of uncertainty. Other participants noted that unless there is clear information that indicates two populations are isolated, there will almost always be some uncertainty in defining the appropriate stocks for management. However, the participants generally agreed that negative evidence (e.g., no differences found) should not automatically lead to lumping. Additionally, it was felt that there is clearly a difference between ESUs and MMPA management units. It was also noted that genetics are not the only criteria for stock differentiation and should not be necessary in all cases to differentiate stocks.

The question still remains -- in an uncertain situation should the default be to split stocks or lump? It was concluded that a management unit is a human construct, and these units are best defined in a way that will facilitate management. In particular, if human-caused mortality occurs in only a portion of a species' geographic range, care should be taken to avoid making the type of mistakes in incorrectly lumping stocks that were shown, by simulations based on real scenarios, to lead to the depletion and potentially the extirpation of some population stocks. Clearly, situations where human impact hit certain segments of the population much harder than others should be carefully scrutinized. It was concluded that splitting was to be preferred in situations where incorrectly lumping could lead to the depletion of a stock. Additionally, the participants agreed that stocks were expected in most cases to be on a scale smaller than entire ocean basins, sometimes much smaller, as shown for small cetaceans in Perrin and Brownell (1994).

On the other hand, it was also felt by most participants that stocks should not be split into unreasonably small units. Some participants felt it might be appropriate to define some sort of minimum split that was reasonable. Others felt that it was probably best to not be too rigid in defining generic limits, as this could lead to problems. Case by case decisions are probably the best that can be done.

Examples of expected stock areas include distinct oceanographic regions (e.g., Gulf of Alaska, California Current, Gulf of Mexico), semi-isolated habitat areas, and areas of higher density of a species that are separated by relatively lower density areas.

It was noted that one could call a population one stock, but then allocate the PBR to geographic regions and not allow the whole PBR to be taken from one specific area. This type of strategy was used to deal with the difficult stock structure of bottlenose dolphins in the bays, sounds, and estuaries in the Gulf of Mexico (Blaylock et al. 1995). It was pointed out that this amounted to little more than a semantic difference, where the management units are termed something other than a stock, but it might be more acceptable to those who equate the word stock with an ESU.

It was pointed out that in the management of terrestrial mammals, states usually use small areas as management units for permitted deer harvests to prevent deer populations from becoming depleted. The management units are understood to often be smaller units than the population, but the managers consider it an effective strategy for preventing population depletion and maintaining harvests.

One difficult aspect of defining stocks is that little may be known about the natural distribution of many species, such as harbor porpoise, and the current distributions are likely human-induced distributions in many cases. In some cases it is uncertain whether areas of low density are the result of past activities of people or are due to how the species chooses to distribute itself.

Some of the participants felt that in the absence of biological stock data it was inappropriate to define stocks to be the area of a fishery's operations. The PBR guidelines used for the 1995 stock assessment reports contained such language in the section that provided guidance on defining stocks. It was noted that the wording of that language did not adequately convey the true intent of the guidance, and it was further noted that there were no stocks that were created solely to be identical to the distribution of a fishery. Therefore, it was agreed that this section of the PBR guidelines should be revised, and that specific statement removed.

The participants agreed that dramatic human-induced contractions in the range of a species should be viewed as a failure to meet the ecosystem goal of the MMPA, even if total population size is still greater than MNPL. It was noted by one participant that it is difficult to define a stock's role as a functioning part of an ecosystem when the ecosystem in many cases is not clearly defined, but others noted that it is not necessary to fully define what the role is to recognize that the role will be missing if the population is gone. However, it was recognized by the participants that what constituted a dramatic contraction in range would be difficult to generically define for all species, as there was not believed to be intent to give protection to animals or groups of animals beyond the margins of their normal population range.

The participants also discussed the merits of establishing some forum for the national review of difficult stock questions. Most of the participants felt that regional reviews, including the regional SRGs, were adequate. It was pointed out that it would be useful if the Alaska and Pacific SRGs held a common meeting to discuss the stock structure of species found in both regions. It was also pointed out that it would be entirely appropriate for an SRG to seek further help with problem stocks, such as inviting an expert(s) to a meeting or soliciting the opinion of a wider circle of scientists with appropriate expertise.

A small working group (Dizon, Heyning, Taylor, Chivers) was formed to revise and clarify the section of the PBR guidelines describing the definition of a stock. After reviewing a draft revision, the workshop participants agreed that the revision was helpful and should be included in the guidelines. The working group made a small number of additional edits to the draft revision after the workshop was completed. The resulting draft is incorporated into the revised draft guidelines in Appendix II.

Major points of agreement/action items:

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

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

The revised definition of stocks section drafted by the working group is useful and helps clarify the intent of stock structure decisions.

4.6 Trans-boundary species

The PBR guidelines as currently written (Barlow *et al.* 1995) give advice on dealing with trans-boundary stocks:

> "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."

Some specific trans-boundary stocks were discussed, such as harbor porpoise and common dolphins in the Atlantic which are both trans-boundary with Canada. For harbor porpoise, the abundance surveys cover both U.S. and Canadian waters, but because little is known about residency time of the animals in either the U.S or Canadian portion of their range, the guidelines were not followed for determining PBR. Mortality was summarized for only the U.S. side but the abundance used to calculate PBR was for the whole area. Some participants noted that the guidelines apparently allow for this type of departure in the face of uncertainty regarding time spent in each country's waters. Others felt that the PBR should be divided up between Canada and the U.S., but did not know how the allocation process should proceed. It is recognized that this should be done, but that it was a political issue, not a scientific issue. Alternately, some felt that an estimate of mortality in Canadian waters should be added to the U.S. mortality estimate for a total estimate of annual human-caused mortality, because this is what is mandated in Section 117 and the abundance estimate that defines PBR is calculated from both U.S. and Canadian waters.

4.7 Incomplete survey of a stock's range

Management of several stocks is hampered by the possibility (for a variety of reasons) that a large portion of a stock's range has not been surveyed, and thus the current abundance estimate is too low by an unknown amount. The workshop participants agreed that there was no scientific basis for extrapolating observed animal densities from a surveyed area into un-surveyed areas.

Additionally, the participants agreed that there was no scientific basis for assuming that N_{min} could be considered to be a point estimate of abundance (which implies that the CV is 0.0) from a survey because the stock was known to have a distribution greater than the survey area (this was done for some stocks in the 1995 SARs).

This situation occurs both for some transboundary stocks and for stocks solely within U.S. waters. Common dolphins in the Atlantic are noted as one stock for which abundance may be underestimated, as surveys over a decade ago (the CETAP surveys) indicated a seasonal movement of common dolphins out of U.S. waters in the summer, presumably into international and Canadian waters to the north and east.

The participants discussed that in these cases it might be useful to calculate the minimum population size necessary to sustain the estimated level of fisheries mortality. This information could help in that there may be a perception that the PBR process has created a problem where none exists because abundance is under-estimated. Calculating the minimum number of animals needed to support a particular level of take makes the issue more concrete. For example, an N_{min} of 45,000 would be necessary for the estimated mortality of 449 common dolphins to be below PBR, an abundance higher than any previous point estimates from the CETAP surveys.

The workshop participants agreed that it would be helpful in most circumstances if the SAR included, where relevant, a map showing the survey area from which the abundance was calculated and any other additional information that is thought useful, such as what areas outside the survey area could possibly be a part of the stock's range. It was noted that the reports are required to "...describe the geographic range of the affected stock, including any seasonal or temporal variation in such range;..." Thus, this suggestion would help provide this mandated information.

Major points of agreement/action items:

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

Where appropriate because abundance is thought to be under-estimated, it would be useful to calculate the minimum population size necessary to sustain the estimated level of fisheries mortality. This information could optionally be included in the SAR.

Each SAR should include a map showing the area within which the survey took place that led to the estimate of abundance. This map could, if appropriate, also include the survey tracklines, sightings of the stock during the survey, and the distribution of the stock outside the survey area.

It was recognized that some abundance methodologies are not dependent upon surveys of the stock's range, and therefore this recommendation may not be appropriate in all SARs. For stocks for which transect surveys have not been done, it may be appropriate to include information about the stock's distribution from other sources, such as photo ID locations or other types of sighting information.

5.0 Annual human-caused mortality and serious injury

5.1 Definition of mortality and serious injury

Under section 118 of the MMPA, fishers must report incidental injuries and mortalities of marine mammals, observer programs typically collect information on mortalities, but under section 118, NMFS must categorize fisheries based on incidental serious injuries and mortalities. The workshop participants were asked to assist NMFS by addressing short- and long-term goals:

Short-term

- provide interim guidelines for determining which injuries are serious for use in this years SARs and in the 1997 LOF
- determine the most appropriate forum for addressing the injury/serious injury question

Long-term

- How will NMFS interpret which of the injuries defined in the regulations are considered serious?
- How (and when) can NMFS modify data collected by observers to determine which injuries are serious?
- How (and when) will information on serious injury be incorporated into SARs and the LOF process?

In discussions, it was pointed out that it would be difficult at sea to distinguish between injuries that lead to mortality and injuries that do not, and that observers and fishermen should not be forced to try to make such determinations. It was agreed that observers and fishermen should both be asked to provide as complete a description of injuries as possible, and that the aid of a checklist helps. Some participants felt it appropriate in some situations to consider all injuries serious, such as the injury of large whales in gillnets. Others felt that such blanket statements may make the process lose credibility. It was also suggested that, in the absence of accurate information, considering 50% of all injuries to be serious may be more appropriate than considering 0% or 100% serious. However, many did not agree with any such generic proposals, as the types of injuries can differ substantially between fishing gear types and the species involved, and thus it was felt that determinations should be case-specific. It was proposed that the SRGs could convene meetings with invited experts to come up with guidelines to defining serious injuries in specific fisheries. One participant noted that this issue had been investigated for sea turtles, and involved scientists had concluded that only through experiments and the collection of specific data on the survival of injured individuals could such issues get resolved.

Discussion raised the following points:

- The agency probably should not consider all injuries in a fishery as mortalities - this reduces the fisher's incentive to release animals and does not reflect current knowledge.
- Different Regions/Centers provide observers with different guidelines for determining whether or not an injury is serious. In addition, different Centers incorporated injury/mortality in the SARs in different ways. Efforts should be made to reconcile these differences.
- Research is needed to determine what injuries should be considered serious.

Because no consensus on the issue was reached, volunteers were solicited for a working group. The working group provided a report of their discussion back to the full workshop (Appendix VII).

After presentation of the working group report, there was general agreement from the workshop participants that assigning a probability of mortality to each injury would be preferable to either calling all injuries "serious injuries", or calling all injuries "not serious". However, there was considerable disagreement regarding what is the most appropriate forum to address the issue.

It was noted that priorities could be set according to the total mortality of a stock relative to its PBR and 10% of its PBR when all injuries are assumed to lead to death. Stocks for which this assumption could lead to a strategic designation should be given the highest priority for research to determine which injuries are serious. It was further recognized that for stocks with total known mortality greater than the PBR, this issue is not of priority now, but as mortality is decreased it may become increasingly important to resolve.

It was suggested by the working group that a workshop should be held to gather people with appropriate expertise to attempt to produce guidelines. Although there was initially some support for convening a workshop to specifically address this subject, some participants indicated that in the absence of solid information, experts would be merely expressing opinions on which injuries were likely lethal, and thus they doubted the usefulness of a workshop at this time. The participants agreed that there was little relevant information currently available on the probability that particular types of visible injuries are lethal for marine mammals.

Major points of agreement/action items:

▸ NMFS should circulate the definition of injury that is included in the regulations. To address this, the following is the regulatory text defining "injury" and "serious injury". Injury is defined specifically in the Code of Federal Regulations (C.F.R.):

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

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

▸ A request should be made to all the regions to provide the list of injuries that are recorded by (1) observers in each observer program, and (2) by fishers on reporting forms. Additionally, it was requested that those who have analyzed observer data provide the definition of "serious injury" that has been used in a particular fishery, if it has been defined.

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

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

If some injuries are currently considered "serious" and are thus counted as mortalities in the mortality estimation, this should be explicitly noted in the report.

▸ Some of the workshop participants recommended that NMFS convene a workshop on the definition of serious injury. Other participants argued that a workshop may not be particularly useful at this time.

5.2 Presentation of information about human-caused mortality in the SARs.
The participants noted that information about fisheries bycatch was, in some cases, difficult to quickly access in the stock assessment reports. This was particularly true for stocks that interact with several fisheries.

Major points of agreement/action items:

A new section should be added to the PBR guidelines which gives guidance about how to present information about annual mortality and serious injury (previously, no guidance was given).

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

Recommend adding a table summarizing incidental fisheries mortality and serious injury to the stock assessment report. Where "serious injury" is distinguished from "mortality" in a fishery, both numbers and their sum should be presented. All fisheries that are noted in the List of Fisheries as interacting with each stock should be in the table.

A sample table be created and distributed to persons responsible for revising the stock assessment reports.

5.3 The description of fisheries in the SARs
Section 117 of the MMPA requires that the SARs :

> (b) "...describe commercial fisheries that interact with the stock, including (A) the approximate number of vessels actively participating in each fishery; ...(C) seasonal or area differences in such incidental mortality and serious injury;..."

Information about fisheries is required to be a part of the SARs. However, the workshop participants recognized that when a fishery interacts with several stocks, information about this fishery gets repeated in several reports. It was agreed that keeping the reports as concise as possible was important, but it was also important (and mandated) that the fisheries information be provided in the reports. Therefore, the participants agreed that if it was a helpful thing to do, redundant information about each fishery could be placed in an appendix to the stock assessment reports. This does not mean that fisheries information must be placed in an appendix, but optionally allows this to be done in cases where it is appropriate. Some participants felt that it may be better to place the fisheries information in a supplemental document, rather than in an appendix, to keep the overall size of the stock assessment report document to a minimum. It was agreed that this, too, was acceptable. However, such a supplement would need to be produced and distributed simultaneously to the stock assessment reports, as information about fisheries is required to be in the reports.

Some participants felt that the most detailed information possible about fisheries should be included in the SARs. It was agreed that maps showing the location of fisheries would be helpful. Some participants felt this should be done for all fisheries known to take marine mammals, even category III fisheries, while others felt that it was only necessary to do this for Category I and II fisheries. For Category I and II fisheries, such maps would be useful for the take reduction teams. Such maps would additionally be useful for the SRGs and NMFS for assessing which unobserved Category II fisheries might have the greatest incidental mortality of marine mammals. The same was felt for some Category III fisheries, in that information regarding their location and size could help in judging whether an unobserved fishery should be investigated. The participants concluded that judgement should be used for category III fisheries, and recommendations from the SRGs would be helpful.

Especially useful information would include the distribution of fisheries effort (i.e., where the fishery fishes). If the exact location of fishing effort is not known, a rough indication of fishing areas and ports the fishery uses would be useful. For observed fisheries, it would also be useful to have a map indicating where fishing activities were observed, and the location of marine mammal mortalities and injuries.

It was recognized that this will initially be a large task, although some participants noted that such information was likely produced for other forums, such as for regional fisheries councils and for section 7 consultations under the ESA. Much of this information is available from NMFS regional offices, so it was recognized that getting this information into the SARs will require close cooperation between the NMFS science centers and the regional offices. Describing the distribution of fisheries, though a large task, is mandated in the MMPA, and was thought to be well worth the effort it will take to provide it.

Major points of agreement/action items:

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

▸ It was recommended that the NMFS Office of Protected Resources circulate a list of what fishery information would be useful to include (see section 3 of Appendix II, the PBR guidelines), and to provide the text of the Environmental Assessment if it would be helpful to those collecting fishery information.

6.0 Habitat issues

Consideration of marine mammal habitat concerns is specifically mandated in the MMPA, as there is a requirement that stock assessments:

> Sec 117 (a)(3) "estimate..., 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;..."

Additionally, the regional Scientific Review Groups are asked to advise the agency on:

> Sec 117 (d)(E) "the actual, expected, or potential impacts of habitat destruction, including marine pollution and natural environmental change, on specific marine mammal species or stocks, and, for strategic stocks, appropriate conservation or management measures to alleviate such impacts;...."

Some public comments expressed the opinion that the 1995 SARs had not adequately addressed this issue. For ESA listed stocks, most of the required data has been put together for biological opinions, but is probably only organized in a convenient fashion for listed stocks that have recovery plans. However, for non-listed strategic stocks (i.e., those stocks that are not listed under the ESA but that have estimated human-caused mortality greater than PBR), the SAR should at least make a statement that no information is available to suggest that habitat issues are likely to be causing a decline or impeding the recovery of the stock, if that is appropriate. It was suggested that information on contaminants, if available, should be included in the SARs. Habitat was recognized as being important to all species; therefore it was concluded that habitat issues should be included for stocks that are not strategic if the data indicate a potential problem.

Major points of agreement/action items:

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

7.0 Research on classifying stocks as strategic

Palka presented research investigating the probability of correctly classifying a stock as strategic or not from a single estimate of abundance and a single estimate of bycatch. Two methods were compared, (1) classifying a stock as strategic when the ratio of the point estimate of bycatch to 1/2Rmax*Nmin is greater than 1.0, and (2) classifying a stock as strategic when the ratio of an upper confidence limit (the 1-s^{th} percentile) of bycatch to ½*Rmax*a lower confidence limit of an abundance estimate (the s^{th} percentile) is greater than 1.0. The first method is analogous to a PBR calculation without using the recovery factor, Fr. The second method was referred to as the percentile-percentile (P-P) method. Estimates of abundance and bycatch were assumed to be log-normally distributed in the analyses. The probability of making a correct classification was determined across a range of CVs for abundance and bycatch. For method 1, this probability surface was found to be non-symmetric, and non-monotonic when the ratio of bycatch to abundance was greater than ½*Rmax. For the percentile-percentile method, the probability surface was found to be symmetric, but was also non-monotonic when the ratio of bycatch to abundance was greater than ½*Rmax, although less-so than method 1. The results led Palka to conclude that one would have to know the true status of the stock to optimally allocate resources between estimating abundance and bycatch. An additional conclusion was that as bycatch is reduced, effort should change towards improving the CV of the abundance estimate at the expense of the CV of bycatch.

Workshop participants noted that two previous analyses presented at the PBR workshop (Barlow et al 1995) had found that when performance was measured by the probability of a population successfully obtaining OSP (which is the primary goal of the MMPA), the CV of bycatch was found to be much less important than the CV of abundance when bycatch is estimated every year, as is currently the case for all category I fisheries (see Wade 1994, Lerczak *et al.* 1994). Further, several participants commented that the analysis presented by Palka was flawed as the appropriate distribution for mortality data in the PBR approach was not used. The workshop participants noted that alternative methods for investigating bycatch should be encouraged and explored, but that the percentile-percentile method as presented could not be implemented. Partly this was thought to be true because the MMPA indicates that the true level of bycatch (and thus an unbiased point estimate) is to be compared to the PBR: "Sec 3(19) The term 'strategic stock' means a marine mammal stock-- (A) for which the level of direct human-caused mortality exceeds the potential biological removal level;..." Additionally, ignoring that difficulty, percentile-percentile could also not be implemented as presented because there had been no selection of a specific percentile to use, and no robustness trials were performed. The participants of the first PBR workshop (Barlow *et al.* 1995) concluded that simulation trials such as those in Taylor (1993) could be used to judge the performance of proposed management schemes, and the workshop participants concluded that such an approach would be a useful evaluation of the proposed percentile-percentile method.

It was noted that an easily understood and transparent management regime is important to the people who are being managed, a point that was also discussed at length in the first PBR workshop (Barlow *et al.* 1995). As a counterpoint, however, some participants noted that useful scientific methods should not be discarded solely because they are complex and difficult to understand. Finally, some of the participants noted that the current PBR calculation method could similarly be implemented for case-specific CV's of abundance and mortality, as suggested in Lerczak (1994), but that the first PBR workshop participants had decided in favor of a more generic approach that covered a range of CV's, that could be adjusted as needed for particular cases.

Wade presented an interactive computer simulation program termed MOKMAM (Monitoring kills of marine mammals). The program was designed to simulate abundance estimates and fisheries mortality estimates under a user-specified level of fisheries mortality. It provides a visual indication of how often a bycatch estimate will be greater than a calculated PBR over a specified time period, such as 10 to 40 years. An example given was that for a cetacean with a true Rmax of 0.04 and an MNPL of 0.5K. Under this scenario a fisheries bycatch of greater than 2% per year would cause the depletion of the population (and thus not meet the goal of the MMPA), while bycatch less than 2% would not cause depletion. The results indicated that for expected precision levels (CVs) of the abundance and mortality estimates, the probability of correctly classifying a stock with bycatch greater than 3% as strategic was very high. Conversely, the probability of correctly classifying a stock with bycatch less than 1% as not strategic was also very high. Making the correct determination for bycatch levels between 1% and 3% depended upon the specified CVs and the exact level of bycatch; when bycatch was very close to 2% it, of course, becomes more difficult to distinguish between a bycatch level just greater than 2% and one just less than 2%. Although a population with bycatch just less than 2% will not become depleted, it will decline from an equilibrium level to a level very close to being depleted, and thus probably deserves close scrutiny. Furthermore, such a level of bycatch is not likely to be considered a level that is insignificant and approaching zero, and will therefore require consideration eventually.

It was suggested by some of the workshop participants that further research along these lines, such as in Smith and Palka (WP-9) and Wade (WP-10), would be useful.

8.0 Calculation of PBRs

A number of issues related to the calculation of PBR were felt to deserve further discussion after the experience of producing the first round of SARs. At the end of many specific discussions it was concluded that the PBR guidelines already contained sufficient guidance. However, there were minor areas where it was felt that some additional guidance might be helpful.

Major points of agreement/action items:

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

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

The participants discussed two issues related to this topic: (1) when estimates of abundance and/or mortality are available for several years, which should be used and how should they be combined, and (2) when no recent information has been collected, at what point does an old estimate become unreliable?

Combining estimates of mortality and abundance from several years will improve the precision of the estimates, reduce the impact on a fishery of a single "bad" year, and create a more stable behavior for the management system. Potential problems from combining estimates across years would be the creation of a lag in the correct evaluation if a substantial trend exists in either abundance or mortality. In other words, if the mortality in a fishery declines substantially, averaging across years might prevent the recognition, for a few years, that a stock was no longer strategic, or the opposite.

It was recognized that it would be appropriate to mathematically weight the most recent estimates more heavily than older estimates, although this may not be overly important if the "window" across which estimates are averaged is kept relatively short.

8.1.1 Abundance estimates

The point was raised about how to deal with situations where it is suspected that one might be seeing different portions of the population in different years, a possible explanation for the large differences in estimates seen between years for some populations, such as gray whales or Gulf of Maine harbor porpoise. Inter-annual oceanographic variability can, for some stocks, lead to distribution shifts, so that one is not seeing the whole population. If this represents the true situation for a stock, averaging across all years will yield an under-estimate of the true stock size, but conversely, arbitrarily throwing away low estimates will yield an over-estimate of the true stock size if the differences in estimates from year to year are only due to sampling variability. The difficulty lies in deciding when evidence supports the hypothesis that fewer animals were available to be surveyed in a year with a lower estimate.

If estimates are combined, it is probably appropriate to use an inverse-variance weighted mean.

Regarding what to do with old estimates, it was noted that the definition of N_{min} states that there is assurance that "stock size is equal to or greater than the estimate" in the Act. At some point, with old estimates we lose this assurance. However, NMFS received public comments and comments from the SRGs expressing dis-satisfaction with the current guidelines which recommends ratcheting down the recovery factor by 10% every year after five years. It was suggested that an alternative would be to state that at some specified "age", abundance estimates become unreliable and at that point N_{min}, and thus PBR, cannot be determined. The workshop participants agreed to this proposal, and also agreed to using eight years as the time period. Many of the participants were not willing to consider a longer time period, as it was pointed out that enormous declines could occur over time periods longer than 8 years. For example, Steller sea lions were observed to decline at a rate of 10% over many years. A population starting at K that declines by 10% per year will be below 50% of K in 8 years. It was noted that for stocks for which it is possible to easily monitor trends in abundance but for which it is more difficult to estimate absolute abundance, that a longer period of time could elapse between absolute abundance estimates if one was confident that the population had not declined in the mean time.

Major points of agreement/action items:

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

8.1.2 Fisheries mortality estimates
The PBR guidelines as written contain no advice on what mortality estimates can or should be used. When combining years of data, it was suggested that we probably do not want to use a weighted mean for mortality. A weighted mean is appropriate when there is more than one estimate of a relatively constant value, but true mortality may itself vary substantially from year to year, and thus an unweighted mean will be a more appropriate measure of the average mortality during the specified time-period.

In the 1995 SARs, the mean of 3 or 4 estimates of mortality were used for many stocks, when such data were available. It may not be appropriate to use more years of data than this, because if as many as 5 years of estimates were used, it is likely that the oldest estimate would be 6 or 7 years old by the time the SAR was finalized. As a rough rule, as many years as necessary to achieve a reasonable CV (e.g., a CV of < 0.2-0.3) could be combined up to some maximum such as 5 years. It will be important to note whether external information gives evidence that true mortality may have changed substantially in recent years. For example, if fishing effort changed substantially, it may not be appropriate to use years prior to the change in the average. It is possible that the most appropriate years of data to use may differ between various fisheries, so each situation will have to be evaluated itself.

Regarding the use of old information, it was suggested that the guidelines should state some sort of time frame beyond which it is recognized that estimates are no longer relevant and useful, as the goal is to evaluate the current bycatch of fisheries. However, if the only information available becomes old, it should not automatically be assumed that the mortality no longer exists unless there is some compelling evidence to suggest that this is the case. It was recognized that in situations where the only information comes from logbook reports of mortalities, the MMPA reports can not be relied upon to necessarily give an accurate picture of current mortality, and so the use of old information may be appropriate.

Major points of agreement/action items:

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

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

8.2 Combining estimates and Calculating CV of a product
The workshop participants discussed a proposal to add a technical supplement to the PBR guidelines providing computational formulas for calculating the combined CV of a product, such as an abundance estimate and its correction factor, and for calculating the combined CV of a weighted mean, as might be used to combine abundance estimates. It was agreed that this would be a useful addition to the guidelines.

Major points of agreement/action items:

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

8.3 Problems associated with species which are difficult to identify
There are several situations in which incidental mortality occurs for cetaceans which are difficult to identify to the species (or stock) level. This has caused greater uncertainty in assessing these stocks, as it is uncertain as to which stock to assign the mortality. Such situations include: *Mesoplodon* beaked whales (potentially 4 species) caught in the Atlantic drift gillnet fishery; *Mesoplodon* beaked whales (potentially 5 species) caught in the Pacific drift gillnet fishery; common dolphins (2 species) caught in the Pacific drift gillnet fishery; Pilot whales (2 species) caught in the Atlantic drift gillnet and longline fisheries; bottlenose dolphins (2 stocks which may deserve taxonomic distinction) caught in the Atlantic drift gillnet fishery and in Atlantic coastal gillnet fisheries; and spotted dolphins (potentially 2 species) caught in the Atlantic drift gillnet fishery. Other species also may be mis-identified, such as a juvenile animal being mistaken for the adult of another smaller, species.

This problem is perhaps most acute in the case of the beaked whales. Two strategies have been used to date to deal with this uncertainty. In the Pacific, *Mesoplodon* beaked whales have been treated as a single management unit, and all species are considered strategic because total *Mesoplodon* mortality exceeds the total *Mesoplodon* PBR. Under such circumstances it is certain that at least one of the species would have its PBR exceeded, if abundance and mortality could be calculated on a species/stock level. For example, consider a hypothetical example where two species cannot be easily identified from each other. Suppose that species 1 should have a PBR of 100 and species 2 should have a PBR of 50. A combined PBR for the two species would be 150. Further suppose that the combined fisheries mortality for the two species is 151. It can be seen that there is no possible way to allocate the mortality of 151 between the two species without exceeding the PBR of species 1 (100), or of species 2 (50), or of both. It can therefore be concluded that at least one of the species is a strategic stock.

In the Atlantic, separate SARs have been written for the 4 *Mesoplodon* spp., but each species is evaluated as if the entire mortality was just of that species. Although abundance was not calculated for the 4 species due to the small number of sightings in surveys and the species identification problem, it is clear that, as in the Pacific, the total PBR that could be calculated for the 4 species would be exceeded by the total mortality.

The workshop participants agreed that more work on identification of species should be done, including further research on strandings and other samples, and the collection of biopsies. However, it was pointed out that even the best observers do not routinely have the opportunity to identify *Mesoplodon* sightings to species, as such identification usually requires the animals to present themselves in a particular way (i.e., usually a clear view of the head of a male is necessary). Tissue samples collected by fisheries observers should eventually be able to determine what species are killed through genetic means if appropriate voucher material can be collected for all species. However, it will be difficult to improve identification during abundance surveys. It was suggested that a revised field guide for beaked whales would help with this issue and should be explored. Tissue materials (and particularly at least the head of beaked whales) are also important voucher materials for establishing what morphologically described species is associated with particular identified genetic sequences.

It was noted that the ability to identify species of *Kogia* in the field is accepted in the Pacific SRG but disputed in the Atlantic SRG, despite many of the same observers being used. The agency's most experienced marine mammal observers note that they see the same identification characters in the Atlantic and Gulf of Mexico as they do in the Pacific, so that there is no reason that there could not be agreement nationally. It was suggested that this should be discussed between the Southeast, Northeast, and Southwest centers, as well as between the Atlantic and Pacific SRGs.

Major points of agreement/action items:

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

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

8.4 Calculating PBR for declining species
It was noted that 3 stocks are known to be declining: western stock of Steller sea lions (PBR=766, abundance= 43,200); Gulf of Alaska harbor seals (PBR not determined, abundance 19,600); and Hawaiian monk seals (PBR=3.9, abundance 1,406). It is thought that none of these stocks are currently declining solely due to direct human-caused incidental mortalities. For Steller sea lions and monk seals, a PBR was calculated but since both are listed under the ESA, the SAR notes that the ESA takes precedence; particularly for monk seals this indicates that zero human related kills are authorized.

It was suggested that there should be criteria for decreasing the recovery factor to account for declining populations. Of course, for endangered stocks such as monk seals the recovery factory is already at its lowest allowable value of 0.1. It was noted that takes of endangered marine mammals can be allowed as long as the take will have a negligible effect on the stock. Where take of a listed stock is known to occur (a total of 10 stocks), for only 3 of those stocks was NMFS able to determine that this take would have a negligible impact (central North Pacific stock of humpback whales, western and eastern stocks of Steller sea lions, 60 FR 45399 August 31 1995). Prior to 1994 a fishery could not be authorized to take an endangered marine mammal, but now the negligible impact standard in the MMPA can be used to support such an authorization.

It was noted that future circumstances involving the decline of a stock not listed under the ESA may justify not calculating a PBR, and such flexibility should be allowed if a new situation merits it. It was concluded that there was no need to revise the guidelines to account for the difficulties of declining populations, as sufficient flexibility to handle special circumstances exists as long as it is documented and justified in the SARs.

8.5 Changing recovery factors from default values (particularly endangered whales)
Some participants felt that a recovery factor of 0.1 may be too conservative for some populations of endangered whales. It was noted that many of these species were listed under the ESA in the early 1970s because no effective international management regime controlling the harvests of large whales was in place. Large whales may not currently be appropriately classified under the ESA in some cases. Some of the participants felt that this issue should be addressed through proposing the de-listing (or down-listing from endangered to threatened) of such stocks under the ESA, and that recovery factors for PBRs under the MMPA should not be altered to fix an incorrect classification under the ESA. Other participants noted that the de-listing process takes a long time, and felt that NMFS should be proactive and, if appropriate and justified by scientific evidence, identify stocks which should have their recovery factor increased. Further, where there was sufficient scientific evidence, it was suggested that NMFS should initiate the delisting process. There was consensus among the participants that candidate stocks should be identified and proposed for de-listing. There was not consensus as to what constituted sufficient evidence to increase the recovery factor or to propose de-listing.

It was noted that in 3 examples, recovery factors for listed stocks had been altered relative to the default recovery factor in the existing PBR guidelines. The recovery factor for bowhead whales (listed as endangered) was raised from 0.1 to 0.5 because the population is thought to be increasing and a management scheme is in place for the subsistence harvest. The recovery factor for the western stock of Steller sea lions, listed as threatened, was decreased from 0.5 to 0.3 because of the decline in the population and anticipation that the population may be listed as endangered in the future. The recovery factor for the eastern stock of Steller sea lions, listed as threatened, was increased from 0.5 to 0.75 on the recommendation of the Alaska SRG, because the population was thought to be stable.

Similar reasoning was used to raise the recovery factor from 0.5 to 1.0 for un-listed stocks subject to subsistence harvest which were thought to be stable. One participant expressed dissatisfaction that there was no definition given for what represented a "stable" stock, and that no statistical criteria had been used to conclude that a stock was stable before increasing the recovery factor.

There was some discussion as to whether changes to the recovery factor for endangered stocks should only occur after changes to their listing status under the ESA had been formally proposed. Most of the participants agreed that it was not appropriate to rigidly link recovery factor values to proposed changes under the ESA. However, some participants still felt that it was not appropriate to increase the recovery factor without sufficient evidence to also initiate the de-listing process, even if they are not formally linked. It was agreed that evidence that an endangered population was increasing was not sufficient evidence to increase the recovery factor, as endangered populations are expected to be increasing if their primary direct human-caused mortality (e.g., harvests) has ceased. The scientific justification for using a recovery factor of 0.1 is based on not significantly delaying the recovery time of an endangered population, so it is not appropriate to raise the recovery factor just because a population is increasing. It was noted that listed species should have recovery teams and recovery plans that specify criteria for de-listing, and that this is not the responsibility of MMPA processes or the SRGs. However, on a pragmatic level, it was noted that the SARs represent the first review in 11 years for some of these listed whale stocks. Some participants suggested we should be wary of effectively reclassifying those stocks where recovery teams do not exist, and that we should set specific standards and not be arbitrary. It was further noted that takes of listed stocks can only be authorized if they have a negligible impact on the population.

Major points of agreement/action items:

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

8.6 Correction factors for deep diving whales

Barlow presented results from field monitoring of deep-diving whales in the Gulf of California, and preliminary work on estimating correction factors for abundance estimates from such data and other information. Beaked whales in particular are hard to see, and dive deeply, although little information is available about their actual dive times. It has been recognized that abundance for beaked whales and other deep-diving whales is under-estimated because during their dives they are unavailable to be seen. However, a lack of information has prevented the quantification of the amount of under-estimation. Therefore, research was conducted to visually monitor deep-diving species to investigate the fraction of time they spend at the surface, and are available to be seen.

Preliminary results indicated that the most frequent dive durations were approximately 15-25 minutes for *Mesoplodon* spp. and 20-35 minutes for *Ziphius cavirostris*. Dive patterns for *Kogia* spp. were highly variable (2-30 minutes), with most dives 20 minutes or less. *Z.cavirostris* spent approximately 1-3 minutes at the surface (or only about 10% of the time), while *Mesoplodon* spp and *Kogia* spent about 2 minutes at the surface. Sperm whales were problematic, as it was difficult to recognize sequential surfacings of individuals because of the presence of several groups of whales diving asynchronously. It was pointed out that such research can only take place under very good sea state conditions.

The next step in estimating correction factors (through the parameter g(0), the probability of detecting a whale if it is at zero perpendicular distance from the ship's transect line) will be to model the searching behavior of observers (including the angle of acuity of the binoculars and the scan rate), the diving behavior of the whales, the detection probability for whales at given radial distances, and the speed of the vessel.

Preliminary results indicated that correction factors for beaked whales will be on the order of 4 to 8 times the abundance estimates from the surveys, but they will have large uncertainties associated with them (i.e., large CVs). It was cautioned that it is unknown whether these estimates would be applicable to other areas or to other similar species. The specific correction factors will only be applicable to abundance estimates from surveys using an identical height platform and identical searching methodology with 25x binoculars and teams of 3 observers. However, the dive time data could conceivably be adapted to estimates from other survey methodologies, but biases could occur if dive times differ in other regions or other times of year, which could be likely as the whales are often diving to the depth of target prey, which will itself vary. Therefore, it was agreed that these correction factors will give an indication of the amount of bias that might be found in other surveys but that it was unlikely to be appropriate to use them to actually correct abundance estimates from surveys of other species in other regions.

8.7 Correction factors for pinniped counts.

There are two primary kinds of correction factors for pinniped counts: correction for the fraction of animals hauled out, and corrections to scale pup counts to the total population size. One of the most difficult aspects of calculating such correction factors is estimating their variance. It was noted that several pinniped stocks in the reports had estimates of Nmin based on counts scaled by correction factors which assumed there was zero variance in the estimated correction factor because of this inability to properly estimate the variance. It was suggested that a default CV on the order of 0.2-0.3 (in the absence of an estimated CV) was probably a more appropriate default than assuming the CV was 0.0. The participants agreed that Mathews (WP-8) was a useful summary of the difficulties in estimating correction factors for pinnipeds.

Major points of agreement/action items:

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

9.0 Review, revision, and publication of the Stock Assessment Reports

The relevant passage from the MMPA states:

"Sec 117 (c) REVIEW AND REVISION. –

(1) The Secretary shall review stock assessments in accordance with this subsection –

(A) at least annually for stocks which are specified as strategic stocks;

(B) at least annually for stocks for which significant new information is available; and

(C) at least once every 3 years for all other stocks."

The participants noted the use of the word "review" here; this implies that it is not necessarily required that reports for the above stocks be revised if the review does not find revision necessary.

9.1 Review and Revision

The workshop participants discussed what constituted a review, and who should do the review. Within NMFS, the Science Centers in most cases have collected the data necessary for calculating PBR, and the Regional Offices in most cases are responsible for fisheries mortality data, although the Centers are also often involved in estimating mortality. In most cases, it is expected that the Science Centers will be the first to have new information when it becomes available, and so must initiate the review process, but the review should involve the NMFS Regional Offices as well. Additionally, the participants agreed that reviewing SARs was one of the primary responsibilities of the regional Scientific Review Groups, so that the review must be a joint process. It was concluded that NMFS Centers and Regions should initiate the process early on by summarizing new data and information that were not available for the previous SARs, and propose which reports need to be revised and what revisions will be necessary. This information should be passed on the SRGs as soon as possible. Then it is expected that the Centers, Regions, and SRGs will have a meeting to discuss the proposed revisions. It was noted that it was also clearly within the responsibility of the SRGs to suggest additional revisions that they consider necessary. For documentation purposes, it was noted that the minutes of the SRG meetings should indicate, when true, that stocks meeting the above criteria in Section 117(c) were reviewed (i.e., considered for revision).

There was much discussion as to whether SARs for stocks with new information but no significant change in status should be revised every year. It was pointed out that many stocks will have an additional year of mortality data available every year, which will often not change any conclusions regarding the status of the stock. In response, it was noted that simply adding a few new estimates would not be overly burdensome, particularly once the process was well established.

It was felt that the SARs were viewed by all involved parties as an important and useful resource, and that having the most current information possible in them was important. It was pointed out that the unavoidable lag time between field work, analysis, final results, and then the drafting and finalization of the SARs often makes information several years old (at best) by the time the SARs are published. The participants thus agreed that SARs should be revised whenever new information is available on the abundance, human-caused mortality, population growth rate, or stock structure of the population. It was agreed that it was best to revise the reports whenever new information was available, even if the new information did not affect whether the stock was strategic or not. For consistency and to avoid confusion, it was also felt best to revise all reports with, for example, new mortality estimates, rather than just reports meeting the specific requirements of Section 117(c). It was also thought to be best to include any reports not revised so that each document is a complete set.

Major points of agreement/action items:

- A section would be added to the PBR guidelines to describe the annual review, revision, and publication of the SARs.

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

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

9.2 Annual schedule for revising and publishing the SARs

Wade and Angliss presented a proposed annual schedule for reviewing stocks, and drafting and finalizing the SARs. The categorization of many fisheries is tied to the calculated PBRs and annual mortality that are presented in the SARs. It was reported that many fishermen felt that the 1995 SARs did not have the most recent information available in them. For example, the 1996 List of Fisheries (LOF), which was finalized at the end of 1995, was based on the 1995 SARs, which in many cases only had information up through 1993 in them (some had 1994 data). However, NMFS was also criticized for basing categorizations on draft SARs, rather than on final SARs. Therefore, the proposed schedule was designed to attempt to have the categorizations in the LOF be based on as recent information as possible, while simultaneously satisfying the objective of basing the proposed categorization on final SARs.

At this point, the group agreed that the best schedule would be one that had field data from the previous year in the draft SARs in time for the LOF for the next year to be finalized by October 1. For example, abundance and fisheries mortality estimates from 1995 would be in draft SARs in the fall of 1996, which would be finalized in the spring of 1997, so that the information could be in the 1998 LOF that is finalized in the fall of 1997.

It was speculated that in future years it may be possible to accelerate this process if it is expected that few changes will occur from one year to the next. Accelerating the process by one year would require developing the SARs and the LOF simultaneously, rather than sequentially, something NMFS was criticized for doing in 1995. If few changes occur, it might be possible to think of a schedule that, for example, would have abundance and fisheries mortality estimates from 1995 incorporated into draft SARs and a proposed 1997 LOF in the late spring of 1996, with both the 1996 SARs and the 1997 LOF finalized in the fall of 1996. However, the workshop participants agreed that a schedule such as this would be too ambitious at this time.

It was further commented that the take reduction team process should be incorporated into this annual schedule, but this may be difficult due to the independent schedules of these teams. It was agreed that timely distribution of new information to the take reduction teams was important, and should not be a problem.

One participant noted that there should be wording in the schedule showing why the time lags exist within the schedule, such as time necessary for analysis of data and peer review. It should also be understood that flexibility exists to incorporate some data later on in the process than called for by the schedule where it is thought to be important, although this should be kept to a minimum. It was suggested that the regions and centers could fine tune the schedule to fit their own needs, but establishing a target schedule will help the process and make clear what certain milestone dates are that can not be delayed, and why they occur when they do. It was further noted that good communications between the centers and regions will assist this process.

The participants agreed to the proposed schedule, and suggested that more explanation of the process would be helpful. It also might be appropriate to expand the time line to incorporate other activities, such as those of the SRGs and regions.

The representatives of all of the NMFS centers and regions agreed to attempt to meet the proposed schedule starting this year. The NMFS scientists responsible for revising the SARs agreed to complete revised drafts by Oct 1, 1996.

It was noted that this was a schedule worked out by NMFS scientists, without consultation with FWS scientists until this workshop. It was also noted that formal communications regarding stock assessments were carried out between the Silver Spring and Washington, D.C. offices of the agencies, rather than between the field scientists writing the SARs. FWS scientists at the workshop noted that the proposed schedule was sensible, but that it may be hard for them to meet the NMFS schedule for various reasons.

Major points of agreement/action items:

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

9.3 Publication issues

The review and revision process is likely to lead to changes to some but not all of the SARs. There was discussion whether only SARs which have changed should be published, or whether all of the SARs should be published together in a single document every year. Publishing only revised SARs would save paper, cost, and time of the personnel responsible for writing, editing, and publishing the documents. Publishing all of the SARs every year, whether revised or not, will prevent confusion as to which SAR is current for each stock, and keep all of the SARs in a single place for ease of reference and distribution. It was suggested that the SARs could be distributed in loose-leaf form to allow insertion of updated material. This idea was thought to be a sound idea for material circulated within the agency, but would be difficult to implement for documents circulated to the general public. Somewhat reluctantly, the participants agreed that all of the SARs should be published every time, as having all the most current information in a single place was thought to be a benefit that outweighed other considerations.

There were several concrete suggestions for assisting this process. It was suggested that a summary of changes since the last publication be included in the document. It was noted again that the suggested appendix containing detailed information regarding fisheries, including maps of the location of fisheries, should also be included in this publication every year. Fisheries are known to be dynamic and subject to rapid changes in fishing location and methods, and so maintaining information as current as possible is important. Most participants felt fisheries information was best presented as an appendix. However, some participants felt that it may be most appropriate to publish the fisheries information in a supplementary document. It was noted that if this was done, both documents would have to be published and circulated simultaneously to meet the mandate of the MMPA.

There was discussion regarding whether or not FWS and NMFS could publish their SARs together in the same regional documents. That would require being on the same time schedule. It was suggested that the SRGs write a letter to the head of both agencies to recommend this. It was suggested that whenever both agencies finalized their SARs, they could at that point be collated and released in a single final document. The workshop participants agreed that the two agencies should try to use a similar process for producing the SARs and that the agencies should push for joint publication.

Major points of agreement/action items:

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

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

9.4 Suggested forum for abundance and mortality estimate manuscripts
The issue of where to publish information used to calculate abundance (and thus PBRs) and mortality estimates was discussed. It was recognized that in the interest of timely incorporation of new information, the SARs will often contain unpublished results. However, it was agreed that the SARs should not become a surrogate for publication of data in more appropriate places. It was also agreed that the agencies should attempt to limit the amount of "gray" literature that is used, and attempt to publish information in peer-review publications as much as possible. Also, it was recognized that it is necessary to cite the primary source for information presented within the SARs. It was noted that the IWC annual reports were a good forum for the continual reporting of annual mortality estimates. It was also noted that the NOAA Technical Memorandums were an acceptable forum for the presentation of information not suitable for publication in a peer-review journal.

It may be appropriate to give a citation of some sort for every estimate of abundance and extrapolated mortality, even if these are only citations of unpublished manuscripts in progress or a "personal communication". The benefit of including such citations would be to try to avoid others from viewing the SARs as the primary location of such estimates, and to minimize external citations to the SARs for such estimates.

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

10.0 List of Fisheries

The workshop participants agreed that a major problem in the classification of fisheries was the lack of information about the level of marine mammal incidental mortality in fisheries which do not have observer programs. The categorization process depends upon having an estimate of mortality, but only a small percentage of fisheries have observer programs which can provide such estimates. Fisheries without observer programs were categorized based on available information, mainly from direct evidence of mortalities such as those reported in logbooks, indirect evidence such as stranding information, and by analogy to similar fisheries which have observer data. Information similar to logbook data will continue to be collected, as the MMPA now requires all fishermen to report all marine mammal mortalities that occur incidental to fishing operations.

It was recognized that only through observer programs could fisheries mortality be fully understood, and the main unresolved problem is how to decide when a fishery should be observed for the first time. In making these decisions, as much information as possible about each fishery is important to help determine the fisheries with the highest priorities for being observed.

Major points of agreement/action items:

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

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

11.0 Take reduction plans

There was a short discussion on progress of take reduction teams (TRT) to date. Only four out of six of the TRTs had been formed, partially due to shortages in both manpower and funds, but also due to the lower priority of two of the teams. In prioritizing what teams needed to be formed, the team for Gulf of Maine harbor porpoise was given the highest priority along with the TRT teams for the drift gillnet fishery off each coast. The fourth team to be formed was that for impacts on endangered large whales (especially right whales). Lower priority was given to Alaska stocks because there were no stocks where incidental fisheries mortality exceeded PBR. Additionally, a TRT for mid-Atlantic states (take of bottlenose dolphins and harbor porpoise) was delayed as little evidence indicating the magnitude of mortality in specific fisheries was available, and therefore the TRT would not know which fisheries for which the take should be reduced, or by how much.

It was noted that NMFS is not absolutely bound to follow the draft Take Reduction Plan submitted by a TRT, but that NMFS likely intended to implement draft plans provided they were consistent with the intent and provisions of the MMPA. Where consensus has not occurred, it was noted that NMFS will have to complete its own plan. NMFS is bound to follow a plan once it has been finalized. Some of the participants noted that it would be helpful for the TRTs to have confirmation from NMFS that indicates NMFS' intention to implement the plans developed by the Take Reduction Teams.

Major points of agreement/action items:

NMFS should confirm to the Take Reduction Teams NMFS' intention to implement the plans developed by the consensus of the Teams.

12.0 Zero Mortality Rate Goal (ZMRG): proposed rule

The proposed rule for the zero mortality rate goal was reviewed and discussed by the workshop participants. The participants agreed that the proposed rule setting ZMRG as 10% of PBR was acceptable for most stocks. However, some felt that the rule resulted in an insignificant threshold that was felt to be too low in some cases, particularly for large whales listed as endangered that were not felt to be in imminent danger of extinction. It was felt that the PBR for endangered stocks was already set at a level that was thought, in one sense, to be insignificant to the recovery of the stock, so that 10% of that level was perhaps an overly conservative number. Additionally, where the total take of all fisheries is greater than 10% of PBR, individual fisheries are evaluated, at least initially, by whether their take is less than 1% of the PBR. Many participants questioned whether this number was overly conservative, although the intent is clear and well motivated to prevent insignificant takes from becoming significant in sum.

Discussion noted that there were two points of view regarding the ZMRG for endangered stocks: (1) that such stocks are deserving of a higher standard because of their endangered status, and (2) that an insignificant level was insignificant for all stocks, including endangered stocks, and so endangered stocks did not need a more conservative level.

A PBR calculated with a recovery factor of 0.5 represents a mortality level which will allow a population to recover to OSP, even under conditions of unknown problems with the estimates of abundance, mortality, R_{max}, or stock structure. Thus, 1% of the PBR of an endangered stock is 1/500 of that mortality level that is estimated would allow recovery, and is 1/100 of the mortality level that is estimated will not significantly delay the time to recovery.

It was noted that the proposed definition for ZMRG is identical to the definition of a Category III fishery, a rule that has already been finalized. It was agreed that it was sensible to keep this consistency, so it was noted that changing ZMRG would likely lead to a proposal to change the rules for categorizing fisheries.

Some participants questioned whether it was the definition of ZMRG that should be discussed, or the recovery factor for endangered whales. It was noted that public comments went from the extremes of considering 10% of PBR too restrictive, to considering any level not restrictive enough unless it approached zero animals killed in a year. The language of the ZMRG section of the MMPA provides some indirect guidance on this issue. Section 118(b)(2) states "fisheries which maintain insignificant serious injury and mortality levels approaching a zero rate shall not be required to further reduce their mortality and serious injury rate." This implies that it is possible for there to be a mortality level greater than zero that meets the ZMRG.

Some participants suggested that NMFS initiate another proposal suggesting the ZMRG should be evaluated at 0.2% of N_{min} for cetaceans , and 0.6% of N_{min} for pinnipeds, except for endangered species which should be evaluated on a case by case basis to determine of their ZMRG should be set at a lower level.

Major points of agreement/action items:

- NMFS should reconsider finalizing the rule defining the Zero Rate Mortality Goal (which is in clearance within NMFS). The proposed rule defines ZMRG to be 10% of PBR, and when total fisheries mortality is greater than 10% of PBR, individual fisheries are said to meet ZMRG if their incidental mortality is less than 1% of PBR. The group agreed that ZMRG should, in principle, be less than PBR. A majority of the participants felt that the proposed rule was appropriate in most cases, and that 10% of a PBR calculated with a recovery factor of 0.5 was appropriate. However, some participants felt that 10% of PBR may be inappropriately low in the particular case of a whale stock listed as endangered which is not perceived to be in imminent danger of extinction (and thus perhaps inappropriately listed as endangered at this time). It was agreed that one possible solution would be to increase the recovery factor, and thus PBR, for such stocks where information warranted such an increase. The participants agreed that another solution would be to retain the proposed definition of ZMRG as 10% of PBR, but amend that definition to include the possibility of establishing ZMRG for endangered species on a case-by-case basis (to not exceed 10% of PBR calculated with a recovery factor of 0.5). The participants also suggested that a possible alternative for establishing ZMRG in a case-specific manner for endangered whales would be to define ZMRG as a % of N_{min}, or as a % of the product (N_{min} x ½ R_{max}), rather than as a percent of PBR.

13.0 The regional Scientific Review Groups

13.1 SRG perspectives

The representatives of the three regional Scientific Review Groups (SRGs) gave their perspectives on the stock assessment process to date. As reported in Barlow *et al.* (1995), the SRGs had mostly agreed with the general guidelines used for calculating PBRs and producing the SARs. In general, the SRG members felt like part of process, and felt that their recommendations were listened to, and that the agency had often, although not always, been responsive to the SRGs. The SRGs felt that additional interaction between the Atlantic, Pacific, and Alaska groups would improve the availability of data sources. In general, the SRGs approved of the content of the SARs. Some SRG members thought it might be appropriate to allow more flexibility to put additional data into the SARs, such as more figures and tables.

It was recognized that on some difficult issues the SRGs were not able to come to a consensus, but that it was useful to try to summarize conflicting points of view in the SRG meeting reports. It was also recognized that in spite of a lack of consensus from the SRG(s), some issues required action so that the agencies will be forced at times to make decisions without full agreement with the SRGs. For example, the Atlantic SRG did not reach a consensus on the proposed rule for ZMRG, the related 10% rule for no significant impact, or on the definition of serious injury. The Alaska SRG noted that their greatest difficulties came in defining stocks, and the use of correction factors for abundance estimates. The Pacific SRG noted that the assessment process was made more difficult because of mixed input from NMFS Regions, Centers, and headquarters offices and related internal communication problems within NMFS. There was agreement that consistency between NMFS and FWS was very important to the entire process.

There was some discussion that the currently defined structure of some stocks found in California, Oregon, and Washington waters, and also Alaska waters may be less than ideal. There was some discussion that a joint meeting between the Pacific and Alaska SRGs to discuss the stock structure of overlapping species would be useful, which was agreed to by all of the workshop participants. Additionally, it was noted that within the Pacific SRG region there may be the need to reconsider and clarify stock structure for some species between California and Oregon/Washington (for example, the stock boundary at the California/Oregon border that is established for harbor porpoise and harbor seals).

Major points of agreement/action items:

It was recommended that the Pacific and Alaska Scientific Review Groups hold a joint meeting with NMFS personnel responsible for marine mammal stock assessments from the Southwest, Northwest, and Alaska Centers and Regions to review stock structure for certain species. Certain species span the Pacific and Alaska SRG regions and it was felt that further discussion was necessary to clarify stock structure between Alaska and WA/OR/CA (for example, killer whales).

13.2 The role of the SRGs

Wade presented a draft document that attempted to describe the role that the SRGs had played in the stock assessment process, and point the way towards the future role of the groups, as well as document some procedural issues regarding the functioning of the groups. The workshop participants agreed that the document was useful and approved it with minor modifications. In a post-workshop review, one SRG member suggested that the tenure of SRG members could be similar to Scientific advisors to the Marine Mammal Commission, which are 3 year terms that can be extended indefinitely.

Major points of agreement/action items:

The proposed plan for the Scientific Review Groups (Appendix VIII) was considered a useful guide to the role of the SRGs in the annual stock assessment process.

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Lt. Scott Hill is due a special thanks for acting as rapporteur of the workshop. The workshop report was greatly improved by the thorough review and comments provided by the participants of the workshop. The report was also greatly improved by comments from the MMPA Task Force and the regional Scientific Review Groups, particularly the careful editing provided by Lloyd F. Lowry. Many thanks are due to Dr. Robert J. Hofman of the Marine Mammal Commission for his comments on the report. Finally, Dr. Jeff Laake kindly provided the first draft of what became the majority of the "Technical details" section of the PBR guidelines as well as Appendix IX (Statistical formulas and background).

Appendix I. Summary of MMPA sections and regulations relevant to Stock Assessments

This appendix summarizes parts of the written text of the U.S. Marine Mammal Protection Act (MMPA) that are relevant to the stock assessment process. Included here are the stated goals of the MMPA, definitions of terms, and portions of Sec. 117 (Stock Assessments) and Sec. 118 (Taking of Marine Mammals Incidental to Commercial Fishing Operations). Also included are some important interpretive definitions established by NMFS through the Federal Register.

The Marine Mammal Protection Act was amended by Congress in 1994. These amendments included Sec. 117, which outlines the requirement that NMFS develop Stock Assessments for all marine mammal stocks which occur in U.S. waters and sets up three Scientific Review Groups to ensure that the assessments include the best available scientific information. These amendments also included Sec. 118, which replaced Sec. 114, and provides a new regime for managing incidental interactions between marine mammals and commercial fisheries. Secs. 117 and 118 are directly related, as the information provided in the SARs is necessary for NMFS to properly implement four major parts of Sec. 118: the List of Fisheries, Take Reduction Teams and Take Reduction Plans, and the progress of fisheries towards the Zero Mortality Rate Goal. In addition, information provided in SARs is also used to assess whether a permit can be issued to some commercial fisheries to incidentally seriously injure or kill endangered or threatened species (Sec. 101(a)(5)(E). The overall goals of the MMPA are in Sec. 2, and definitions are provided in Sec. 3.

MMPA Sec. 2. Findings and Declaration of Policy (16 U.S.C. 1361[1])

Management goals of the MMPA

Sec. 2. (2) Marine mammals "...should not be permitted to diminish beyond the point at which they cease to be a significant functioning element in the ecosystem of which they are a part, and, consistent with this major objective, they should not be permitted to diminish below their optimum sustainable population. Further measures should be immediately taken to replenish any species or population stock which has already diminished below that population."

Sec. 2."(6) marine mammals have proven themselves to be resources of great international significance, esthetic and recreational as well as economic, and it is the sense of the Congress that they should be protected and encouraged to develop to the greatest extent feasible commensurate with sound policies of resource management and that the primary objective of their management should be to maintain the health and stability of the marine ecosystem. Whenever consistent with this primary objective, it should be the goal to obtain optimum sustainable population keeping in mind the carrying capacity of the habitat"

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[1]U.S.C. refers to a law established by the United States Congress.

MMPA Sec. 3. Definitions (16 U.S.C. 1362)

Depleted Stock
Sec. 3. "(1) The term 'depletion' or 'depleted' means any case in which -

> (A) the Secretary, after consultation with the Marine Mammal Commission and the Committee of Scientific Advisors on Marine Mammals established under title II of this Act, determines that a species or population stock is below its optimum sustainable population;"

Optimum sustainable population (OSP)-- MMPA definition
Sec. 3."(9) The term 'optimum sustainable population' means, with respect to any population stock, the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element."

Optimum sustainable population (OSP)--NMFS interpretive definition
The definition of OSP above provided in the MMPA has been interpreted by NMFS (50 C.F.R. 216.3[2]) to mean the following:

"Optimum sustainable population is 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 which results in maximum net productivity."

"Maximum net productivity is the greatest 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."

Population stock
Sec. 3."(11) The term 'population stock' or 'stock' means a group of marine mammals of the same species of smaller taxa in a common spatial arrangement, that interbreed when mature."

Strategic stock
Sec. 3."(19) The term 'strategic stock' means a marine mammal stock -

> (A) for which the level of direct human-caused mortality exceeds the potential biological removal level;
>
> (B) which, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the Endangered Species Act of 1973 within the foreseeable future; or

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[2]C.F.R. refers to a regulation established in the Code of Federal Regulations.

(C) which is listed as a threatened or endangered species under the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), or is designated as depleted under this Act."

Potential Biological Removal Level (PBR) -- MMPA definition
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 recovery factor of between 0.1 and 1.0."

Net productivity rate
Sec. 3."(26) The term 'net productivity rate' means the annual per capita rate of increase in a stock resulting from additions due to reproduction, less losses due to mortality."

Minimum population estimate (N_{min})
Sec. 3."(27)The term 'minimum population estimate' means an estimate of the number of animals in a stock that -

(A) is based on the best available scientific information on abundance, incorporating the precision and variability associated with such information; and

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

Potential Biological Removal (PBR) -- NMFS' interpretive definition
NMFS published proposed guidelines for calculating PBR, along with a notice of availability of draft stock assessment reports, on August 4, 1994 (59 FR 40527[3]). The final definition for calculating PBR was published along with the notice of availability of final stock assessment reports on August 25, 1995 (60 FR 44308). The full guidelines for preparing the 1995 stock assessment reports was published in Barlow, J., S.L. Swartz, T.C. Eagle, and P. R. Wade, 1995 (U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 p). The MMPA defined PBR to be the product of a minimum population estimate (N_{min}), ½ the maximum net productivity rate (R_{max}), and a recovery factor (F_R). The final guidelines for calculating PBR defined those three terms as:

[3]FR refers to the Federal Register.

N_{MIN}= (1) the 20th percentile (lower 60% confidence limit) of the log-normal distribution resulting from a point estimate of abundance and its CV, or (2) a direct count of animals such as a count of hauled-out pinnipeds.

R_{MAX}= (1) a default value of 0.04 for cetaceans and manatees and 0.12 for pinnipeds and sea otters, or (2) a reliable stock specific estimate can be used if available and accepted in a peer-review journal or accepted by a review groups such as a regional Scientific Review Group or the Scientific Committee of the International Whaling Commission.

F_R= 0.1 for stocks listed as endangered, 0.5 for stocks that are listed as threatened or depleted or are of unknown status if the CV of the mortality estimate is less than or equal to 0.3 (should be adjusted to 0.48 if CV=0.3-0.6, 0.45 if CV=0.6-0.8, and 0.4 if CV>0.8), and 1.0 for stocks known to be within OSP. The PBR guidelines describe circumstances that allow further adjustments of the recovery factor.

MMPA Sec. 117: Stock Assessments (16 U.S.C. 1386)

Stock Assessment Reports (SARs)
Sec. 117 (a)(1) NMFS shall "... prepare a draft stock assessment for each marine mammal stock which occurs in waters under the jurisdiction of the United States. Each draft stock assessment, based on the best scientific information available, shall —

(1) describe the geographic range of the affected stock, including any seasonal or temporal variation in such range;

(2) provide for such stock the minimum population estimate, current and maximum net productivity rates, and current population trend, including a description of the information upon which these are based;

(3) estimate the annual human-caused mortality and serious injury of the stock by source 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) describe commercial fisheries that interact with the stock, including --

(A) the approximate number of vessels actively participating in each such fishery;

(B) the estimated level of incidental mortality and serious injury of the stock by such fishery on an annual basis;

(C) seasonal or areal differences in such incidental mortality and serious injury;

(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;

(5) categorize the status of the stock as one that either --

(A) 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; or

(B) is a strategic stock, with a description of the reasons therefor; and

(6) estimate the potential biological removal level for the stock, describing the information used to calculate it, including the recovery factor."

MMPA Sec. 118: Taking of marine mammals incidental to commercial fishing operations (16 U.S.C. 1387)

Sec. 118 of the MMPA contains the following subsections: (a) in general, (b) zero mortality rate goal, (c) registration and authorization, (d) monitoring of incidental takes, (e) reporting requirement, (f) take reduction plans, (g) emergency regulations, (h) penalties, (i) assistance, (j) contributions, (k) consultation with Secretary of the Interior, and (l) definitions. A few of the relevant parts of Sec. 118 are given below.

The goal of Sec. 118

Sec. 118 "(a) (1) Effective on the date of enactment of this section [April 30, 1994], and except as provided in section 114 and in paragraphs (2), (3), and (4) of this subsection, the provisions of this section shall govern the incidental taking of marine mammals in the course of commercial fishing operations by persons using vessels of the United States or vessel which have valid fishing permits issued by the Secretary in accordance with section 204(b) of the Magnuson Fishery Conservation and Management Act (16 U.S.C. 1824(b)). In any event it shall be the immediate goal that the incidental mortality or serious injury of marine mammals occurring in the course of commercial fishing operations be reduced to insignificant levels approaching a zero mortality and serious injury rate within 7 years after the date of enactment of this section [April 30, 2001]."

It should be noted that it is specifically stated that Sec. 118 does not govern the incidental taking of marine mammals in the purse seine fishery for yellowfin tuna in the eastern tropical Pacific Ocean or the incidental taking of California sea otters.

The list of fisheries (LOF) -- MMPA definition
Sec. 118 (c) (1) "The Secretary shall...

> (A) publish in the Federal Register for public comment, for a period of not less than 90 days, any necessary changes to the Secretary's list of commercial fisheries published under section 114(b)(1)..., with respect to commercial fisheries that have —
>
> > (i) frequent incidental mortality and serious injury of marine mammals;
> >
> > (ii) occasional incidental mortality and serious injury of marine mammals;
> >
> > (iii) a remote likelihood of or no known incidental mortality and serious injury of marine mammals;
>
> (B) after the close of the period for such public comment, publish in the Federal Register a revised list of commercial fisheries...; and
>
> (C) at least once each year thereafter...reexamine... the classification of commercial fisheries and other determinations required under subparagraph (A) and publish in the Federal Register any necessary changes."

List of Fisheries (LOF) -- NMFS' interpretive definition
Proposed and final regulations implementing Sec. 118 were published in the Federal Register in 1995. The implementation of Sec. 118 relies on the information provided in the Stock Assessment Reports developed pursuant to Sec. 117.

Under Sec. 118, NMFS must classify all U.S. commercial fisheries based on the level of marine mammal serious injury and mortality that occurs incidental to each fishery. While all participants in all commercial fisheries must report incidental takes, fisheries that have a high or occasional level of serious injury or mortality are subject to more regulations than are fisheries that have a remote likelihood or no known incidental serious injuries or mortalities of marine mammals. Fisheries with high, occasional, or a remote likelihood of marine mammal serious injuries and mortalities are referred to as Category I, II, and III fisheries, respectively.

Under the old Sec. 114, the criteria used to classify commercial fisheries as having "high", "occasional", or "remote likelihood or no known" takes were based on a rate of cumulative marine mammal deaths (regardless of what stock of marine mammal) per 20 days. The final regulations implementing Sec. 118 defined the fishery classification criteria using a stock-specific approach, as the impact of fishery removals to individual stocks is likely more important than the total number of animals taken during an arbitrary period of time.

The List of Fisheries, which NMFS must publish at least annually, evaluates U.S commercial fisheries based upon a two tiered, stock-specific approach that first addresses the total impact of all fisheries on each marine mammal stock and then addresses the impact of individual fisheries on each stock. This approach is based on the rate, in numbers of animals per year, of serious injuries and mortalities that occur incidental to commercial fishing relative to the Potential Biological Removal level (PBR) for each marine mammal stock. While the actual definitions of the fishery classification criteria can be found in the Federal Register notice published to announce the final regulations implementing Sec. 118, it is more convenient to consider the following approach to fishery evaluation:

> Tier 1: If the total annual mortality and serious injury across all fisheries that interact with a stock is less than or equal to 10 percent of the PBR of such a stock, then all fisheries interacting with this stock would be placed in Category III. Otherwise these fisheries are subject to the next tier to determine their classification.
>
> Tier 2-Category I: Annual mortality and serious injury of a stock in a given fishery is greater than or equal to 50 percent of the PBR level.
>
> Tier 2-Category II: Annual mortality and serious injury in a given fishery is greater than 1 percent and less than 50 percent of the PBR level.
>
> Tier 2-Category III: Annual mortality and serious injury in a given fishery is less than or equal to 1 percent of the PBR level.

Information used in the LOF includes descriptions of commercial fisheries, fishery-specific mortality and serious injury levels of marine mammals, and PBRs for those stocks taken in the fishery.

Because information in the Stock Assessment Reports impact the List of Fisheries in two ways - via the PBR and the fishery-specific mortality level, changes in these values may change the classification of a commercial fishery.

The regulatory requirements for Category I and II fisheries are essentially identical. Participants in fisheries placed in Category I or II must register in the Marine Mammal Assessment Program and pay the registration fee, and vessels must carry an observer if requested. All fishers, regardless of which fishery they participate in, must report incidental injuries and mortalities of marine mammals to NMFS within 48 hours of returning from a fishing trip. Aside from the mandatory reporting requirement, there are no further regulatory requirements for Category III fisheries: participants are not required to register and do not have to carry an observer if requested. Thus, there is an impact on the fishery if the classification changes from a III to a Category I or II, and a corresponding decrease in regulatory requirements if a fishery changes from a Category I or II to a Category III.

Zero Mortality Rate Goal -- MMPA definition
Sec. 118 "(b) Zero Mortality Rate Goal—

> (1) Commercial fisheries shall reduce incidental mortality and serious injury of marine mammals to insignificant levels approaching a zero mortality and serious injury rate within 7 years after the date of enactment of this section [April 30, 2001].
>
> (2) Fisheries which maintain insignificant serious injury and mortality levels approaching a zero rate shall not be required to further reduce their mortality and serious injury rates.
>
> (3) Three years after such a date of enactment [April 30, 1997], the Secretary shall review the progress of all commercial fisheries, by fishery, towards reducing incidental mortality and serious injury to insignificant levels approaching a zero rate. The Secretary shall submit to...the Senate and the...House of Representatives a report setting forth the results of such review within 1 year after commencement of the review....
>
> (4) If the Secretary determines after review under paragraph (3) that the rate of incidental mortality and serious injury of marine mammals in a commercial fishery is not consistent with paragraph (1), then the Secretary shall take appropriate action under subsection (f)."

Note that subsection (f) describes the Take Reduction Plan process. Therefore, commercial fisheries not meeting the ZMRG after the review (due in 1998) will be required to have a Take Reduction Team formed to create a Take Reduction Plan designed to meet the ZMRG.

Zero Mortality Rate Goal -- NMFS proposed interpretive definition
Sec. 118 indicates that all fisheries should strive to attain the "Zero Mortality Rate Goal", (ZMRG) and requires that NMFS assess the progress of commercial fisheries towards this goal in a report initiated in April 1997 and presented to Congress by April of 1988. Congress did not, however, define this goal.

A proposed definition of the ZMRG was included in the proposed implementing regulations for Sec. 118. The proposed definition published at that time was identical to the proposed definition of a Category III fishery[4]. The parallel definitions had the following advantages: 1) the List of Fisheries process would determine implicitly which fisheries had met the ZMRG, 2) the consideration of both individual and cumulative fishery impact to stocks would be considered in the ZMRG, and 3) the ZMRG would have a stock-specific approach and use PBR and mortality values provided through Sec. 117. In addition, the proposed definition would be based on measurable, quantifiable criteria and the definition would be conservative, as it would be synonymous with having a "remote likelihood or no known take". Using the proposed definition

[4] The final definition of a Category III fishery did not change substantially from the proposed definition. Thus, the Tier 1-Tier 2 discussion of a Category III fishery included in the above List of Fisheries section is the same as the proposed definition of the ZMRG.

for ZMRG, the information in the SARs used to determine whether a fishery should be classified in Category III also determines whether a fishery has met the ZMRG.

NMFS received many comments on the proposed definition of the ZMRG. In order to evaluate the comments carefully, NMFS did not publish a final definition for ZMRG when the final implementing regulations for Sec. 118 were published late in 1995. The Federal Register notice announcing the final definition of ZMRG was removed from the clearance process when significant questions were raised during discussion about NMFS' approach at the GAMMS workshop in April of 1996.

Take Reduction Plan goals -- MMPA definition
Sec. 118 "(f) Take Reduction Plans. —

> (1) The Secretary shall develop and implement a take reduction plan designed to assist in the recovery or prevent the depletion of each strategic stock which interacts with a commercial fishery listed under subsection (c)(1)(A)(i) or (ii), and may develop and implement such a plan for any other marine mammal stocks which interact with a commercial fishery listed under subsection (c)(1)(A)(i) which the Secretary determines, after notice and opportunity for public comment, has a high level of mortality and serious injury across a number of such marine mammal stocks.
>
> (2) The immediate goal of a take reduction plan for a strategic stock shall be to reduce, within 6 months of its implementation, the incidental mortality or serious injury of marine mammals incidentally taken in the course of commercial fishing operations to levels less than the potential biological removal level established for that stock under section 117. The long-term goal of the plan shall be to reduce, within 5 years of its implementation, the incidental mortality or serious injury of marine mammals incidentally taken in the course of commercial fishing operations to insignificant levels approaching a zero mortality and serious injury rate, taking into account the economics of the fishery, the availability of existing technology, and existing State or regional fishery management plans."

Take Reduction Plans -- NMFS implementation
Under Sec. 118, NMFS is required to convene Take Reduction Teams (TRTs) for each strategic stock that interacts with a Category I or II fishery. Each team's primary objective is to develop a plan for reducing the fishery-specific incidental mortality and serious injury for each strategic stock.

The coordination of the TRT process was initiated in 1995. Each team is to consist of individuals who represent the variety of interested or affected parties from the commercial and recreational fishing industry, appropriate Regional Fishery Management Councils, interstate fisheries commissions, academic and scientific organizations, state officials, native Alaskans or other Native Americans if appropriate, and environmental groups. A pilot study conducted through the NMFS Office of Protected Resources indicated that the parties likely to be involved in TRTs felt that all viewpoints would be equally represented at the table only if a professional facilitator not associated with NMFS conducted the TRT meetings.

NMFS contracted a professional facilitation group with expertise in environmental dispute resolution in September of 1995. The contractor was responsible for compiling the team participants, convening six Take Reduction Teams, and facilitating their development of Take Reduction Plans in 1996. Take Reduction Teams have been formed or are planned for the following stocks or groups of stocks: Gulf of Maine harbor porpoise, Atlantic offshore cetaceans, Pacific offshore cetaceans, Atlantic baleen whales (humpback and right whales), Atlantic coastal bottlenose dolphins and harbor porpoise, and Alaska strategic stocks.

Take Reduction Teams must develop Take Reduction Plans within 6 months of the team's formation. Once a plan has been developed, NMFS has 6 months in which to implement the plan through publication of regulations in the Federal Register. NMFS will give the maximum weight possible to a plan that is developed by consensus of the TRT members.

Stock Assessment Reports are used extensively during the TRT/TRP process, as these reports provide the best available information on the abundance, distribution, and fishery-specific incidental mortality of marine mammals.

Incidental takes of ESA listed species -- MMPA mandate

Sec. 118 (a)(2) "In the case of incidental taking of marine mammals from species or stocks designated under this Act as depleted on the basis of their listing as threatened species or endangered species under the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), both this section and section 101(a)(5)(E) of this Act apply."

Sec. 101(a)(5)(E)(i) "....the Secretary shall allow the incidental, but not intentional, taking...in commercial fishery operations, of marine mammals from a species or stock designated as depleted because of its listing as an endangered or threatened species under the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), if the Secretary, ...determines that —

> (I) the incidental mortality and serious injury from commercial fisheries will have a negligible impact on such species or stock;
>
> (II) a recovery plan has been developed or is being developed for such species or stock pursuant to the Endangered Species Act of 1973; and
>
> (III) where required under section 118, a monitoring program is established under subsection (d) of such section, vessels engaged in such fisheries are registered in accordance with such section, and a take reduction plan has been developed or is being developed for such species or stock."

Negligible impact of ESA listed species -- NMFS interpretive definition
Sec. 101(a)(5)(E) of the MMPA allows for the incidental serious injury and mortality of marine mammals listed as endangered or threatened under the ESA provided that the incidental mortality and serious injury will have a negligible impact on the affected species or stock. In order to determine whether commercial fishing activities are having a negligible impact on endangered or threatened species of marine mammals, NMFS evaluated the total number of all incidental serious injuries and mortalities due to commercial fishing for each stock, based on information included in the final SARs and the Environmental Assessment prepared to accompany the proposed implementing regulations for Sec. 118.

Negligible impact, as defined in 50 CFR 228.3, is "an impact resulting from the specified activity that cannot be reasonably expected to , and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival." Because this definition is qualitative rather than quantitative, NMFS used both qualitative and quantitative guidelines to determine whether the take was negligible. NMFS determined that mortality and serious injury of the Central North Pacific stock of humpback whales and both stocks of Steller sea lions was negligible, and issued a general interim permit to fisheries that take only these stocks and no others listed as endangered or threatened.

Citations of relevant Federal Register notices

Proposed 118 regs/LOF for 1996:	June 16, 1995, 60 FR 31666
Final 118 regs:	August 30, 1995, 60 FR 45086
Final LOF for 1996:	December 28, 1995, 60 FR 67063
Proposed LOF for 1997:	July 16, 1996, 61 FR 37035
Final LOF for 1997:	January 2, 1997, 62 FR 33
Taking of threatened & endangered marine mammals:	August 31, 1995, 60 FR 45399
Draft SARs/PBR guidelines:	August 4, 1994, 59 FR 40527
Final SARs/PBR guidelines:	August 25, 1995, 60 FR 44308

Other documents

NMFS, 1995. Environmental Assessment of proposed regulations to govern interactions between marine mammals and commercial fishing operations under Sec. 118 of the Marine Mammal Protection Act. 137p. + appendices.

NMFS, 1995. Assessment of fishery impacts on endangered and threatened marine mammals pursuant to Sec. 101(a)(5)(E) of the MMPA. 21p.

Appendix II. Guidelines for preparing the Stock Assessment Reports (PBR guidelines)

The guidelines for preparing Stock Assessment Reports ("the PBR guidelines") were revised following discussions and recommendations of the GAMMS workshop in April, 1996. The 1996 draft Stock Assessment Reports were prepared based on those revised guidelines. These revised PBR guidelines are included on the following pages.

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

1. General Guidelines

Introduction

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

The MMPA requires Reports to include, among other things, information on how stocks were 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 document provides guidance for how these topics are to be addressed in the Reports.

The MMPA provides some general guidance for developing the Reports; more detailed guidelines were developed at the PBR Workshop in June 1994 and were used in writing the original draft Reports. These original guidelines together with the draft PBR guidelines, were made available for public comment in August 1994 (59 FR 40527). Subsequently, the MMPA Scientific Review Groups met jointly in October 1994 to review the guidelines and to make recommendations for changes. These guidelines are based on the original PBR Workshop guidelines (see Barlow *et al.* 1995) as modified according to public comments and on the consensus recommendations from the Scientific Review Groups, FWS, and NMFS staff. Further modifications were made based on recommendations of the GAMMS Workshop in April of 1996 (Wade and Angliss, 1997). 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 document do not have to be followed rigidly; however, any departure from these guidelines must be discussed fully within any affected Report.

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

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

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

Definition of "Stock"

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

Many types of information can be used to identify stocks of a species: distribution and movements, population trends, morphological differences, genetic differences, contaminants and natural isotope loads, parasite differences, and oceanographic habitat differences. Evidence of morphological or genetic differences in animals from different geographic regions indicates that these populations are reproductively isolated. Reproductive isolation is proof of demographic isolation, and thus separate management is appropriate when such differences are found. Failure to detect differences experimentally, however, does not mean the opposite. Dispersal rates, though sufficiently high to homogenize morphological or genetic differences detectable experimentally between putative populations, may still be insufficient to deliver enough recruits from an unexploited population (source) to an adjacent exploited population (sink) so that the latter remains a functioning element of its ecosystem. Insufficient dispersal between populations where one bears the brunt of exploitation coupled with their inappropriate pooling for management could easily result in failure to meet MMPA objectives. For example, it is common to have human-caused mortality restricted to a portion of a species' range. Such concentrated mortality (if of a large magnitude) could lead to population fragmentation, a reduction in range, or even the loss of undetected populations, and would only be mitigated by high immigration rates from adjacent areas.

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

In trans-boundary situations where a stock's range spans international boundaries or the boundary of the U.S. Exclusive Economic Zone (EEZ), the best approach is to establish an international management agreement for the species. In the interim, if a stock is migratory and it is reasonable to do so, the fraction of time in U.S. waters should be noted, and the PBR for U.S. fisheries should be apportioned from the total PBR based on this fraction. In a non-migratory situation, the PBR for U.S. fisheries should be calculated based on the abundance estimate of the stock residing in U.S. waters. For situations where a species with a broad pelagic distribution which extends into international waters experiences mortalities within the U.S. EEZ, PBR calculations should be based on the abundance in the EEZ 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. Further specific guidance on the calculation of PBR is provided in part 2 (Technical Details) of this document.

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):

$$N_{min} = N/\exp(0.842 * (\ln(1+CV(N)^2))^{½}) \qquad (1)$$

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

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

Maximum Rate of Increase (R_{max})

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

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

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

Recovery Factor (F_r)

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

The recovery factor can be adjusted to accommodate additional information and to allow for management discretion as appropriate and consistent with the goals of the MMPA. For example, if human-caused mortalities include more than 50% females, the recovery factor should be decreased to compensate for the greater impact of this mortality on the population (or increased if less than 50% female). Similarly, declining stocks, especially ones that are threatened or depleted, should be given lower recovery factors, the value of which should depend on the magnitude and duration of the decline. The recovery factor of 0.5 for threatened or depleted stocks or stocks of unknown status was determined based on the assumption that the coefficient of variation of the mortality estimate is equal to or less than 0.3. If the CV is greater than 0.3, the recovery factor should be decreased to: 0.48 for CVs of 0.3 to 0.6; 0.45 for CVs of 0.6 to 0.8; and 0.40 for CVs greater than 0.8.

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

Annual human-caused mortality and serious injury

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

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

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

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

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

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

Mortality Rates

Sec. 118 of the 1994 MMPA Amendments reaffirmed the goal set forth in the Act when it was enacted in 1972 that the take of marine mammals in commercial fisheries is to be reduced to insignificant levels approaching zero mortality and serious injury rate, and further requires that this goal be met within 7 years of enactment of the 1994 Amendments (April 30, 2001). This fisheries-specific goal is referred to as the "zero mortality rate goal" (ZMRG). The Stock

Assessment Reports are not the vehicle for publishing determinations as to whether a specific fishery has achieved the ZMRG. A review of progress towards the ZMRG for all fisheries is required to be submitted to Congress by April 30, 1998.

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

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

Status of Stocks

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

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

The MMPA requires for strategic stocks a consideration of other factors that may be causing a decline or impeding recovery of the stock, including effects on marine mammal habitat and prey. Therefore, such issues should be summarized in the Status section for all strategic stocks. If substantial issues regarding the habitat of the stock are important, a separate section titled "Habitat Issues" should be used. If data exist that indicate a problem, they should be summarized and included in the Report. If there are no known habitat issues or other factors causing a decline or impeding recovery, this should be stated in the Status section.

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Barlow, J., S.L. Swartz, T.C. Eagle, and P. R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 p.

Dizon, A. E., C. Lockyer, W. F. Perrin, D. P. DeMaster, and J. Sisson. 1992. Rethinking the stock concept: a phylogeographic approach. Conserv. Biol. 6(1):24-36.

Perrin, W. F., and R. L. Brownell, Jr. 1994. A brief review of stock identity in small marine cetaceans in relation to assessment of driftnet mortality in the North Pacific. Rep. Int. Whal. Comm. Spec. Iss. 15:393-401.

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2. Technical Details

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

Precision and Rounding

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

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

Computation of Average Abundance and its Variance

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

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

where:

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

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

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

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

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

Computation of Average Human-Caused Mortality and its Variance

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

Calculating the overall mean annual by-catch

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

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

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

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

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

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

Method 1

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

Method 2

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

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

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

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

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

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

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

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

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

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

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

3. Descriptions of U.S. commercial fisheries

Fisheries table in each stock assessment report

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

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

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

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

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

General information about a fishery (not stock-specific)

Information to provide

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

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

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

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

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

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

Seasons: Describe the seasons during which the fishery operates.

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

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

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

Comments: Include any additional relevant information on the fishery.

Sources of information on U.S. commercial fisheries

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

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

4. Recommendations of the GAMMS Workshop

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

4.5 Discussion on the definition of stocks

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

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

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

4.7 Incomplete survey of a stock's range

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

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

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

5.1 Definition of mortality and serious injury

▸ NMFS should circulate the definition of injury that is included in the regulations. To address this, the following is the regulatory text defining "injury" and "serious injury". Injury is defined specifically in the C.F.R. (final regulations for implementation of Section 118):

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

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

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

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

5.2 Presentation of information about human-caused mortality in the SARs.

▸ A new section should be added to the PBR guidelines which gives guidance about how to present information about annual mortality and serious injury (previously, no guidance was given).

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

▸ A table summarizing incidental fisheries mortality and serious injury should be added to the SAR. Where "serious injury" is distinguished from "mortality" in a fishery, both numbers and their sum should be presented. All fisheries that are noted in the List of Fisheries as interacting with each stock should be in the table.

▸ A sample table for reporting information about incidental mortality and serious injury in commercial fisheries should be created and distributed to persons responsible for revising the

SARs.

5.3 The description of fisheries in the SARs

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

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

6.0 Habitat issues

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

8.0 Calculation of PBRs

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

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

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

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

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

8.2 Combining estimates and Calculating CV of a product

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

8.3 Problems associated with species which are difficult to identify

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

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

8.5 Changing recovery factors from default values (particularly endangered whales)

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

8.7 Correction factors for pinniped counts.

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

9.1 Review and Revision

- A section would be added to the PBR guidelines to describe the annual review, revision, and publication of the SARs.

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

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

9.2 Annual schedule for revising and publishing the SARs

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

9.3 Publication issues

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

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

9.4 Suggested forum for abundance and mortality estimate manuscripts

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

10.0 List of Fisheries (Section 118)

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

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

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Appendix III. GAMMS workshop agenda, April 3-5, Seattle, WA

Wednesday: 9:00-5:20 pm

Introduction

(5 min)	Welcome (Balsiger)
(5 min)	Introduction (Wade)
(20 min)	Logistics, Agenda, and Ground-rules (Angliss)

Background information presentations

(5 min)	Final List of Fisheries categorization rule (Angliss)
(5 min)	Final ZMRG rule (Eagle)
(20 min)	Strategic stocks: brief review of what is happening with Take Reduction Teams (Beach/Lagomarsino/Wang)
(30 min)	SRG perspectives (Brault/Heyning/Straley/Hild)
(15 min)	Break (10:30-10:45)

Stock structure

(15 min)	Introduction: what sort of stock structure should we expect? (Presentation: Heyning)
(30 min)	Review of relevant types of information available for making stock decisions, especially genetic data (Presentation: Dizon)
(30 min)	The stock decision process (Presentation: Taylor)
(30 min)	Presentation and exercises running a simulation model showing the consequences of stock structure decisions. Participants are encouraged to bring a lap-top PC if possible (group exercise: Taylor)
(70 min)	Working Lunch (12:30-1:40)
(30 min)	Review of available and needed data for making stock decisions (Presentation: Chivers).
(60 min)	Should the "Definition of Stocks" section be revised, supplemented, or left alone? Are the current guidelines adequate? (Discussion: DeMaster)
(30 min)	Discussion of specific problems in defining stocks for trans-boundary species (Discussion: Waring)
(20 min)	Break (3:30-3:50)
(10 min)	Do we need a very specific description of the geographic range of each stock in the SARs (i.e., define specific borders of stock area) (Discussion: group)
(20 min)	How should stocks be reviewed, would review at a national level help for stocks of difficult species? (Discussion: group)

Fisheries, mortality estimates and other information

(30 min) Definition of "mortality and serious injury" (Discussion: Angliss)
(10 min) Proposed fisheries table to be included in each SAR (Discussion: Wade)
(20 min) Geographic description of fishing effort and incidental mortality for category I and II fisheries: a proposed supplement to the SARs (Discussion: Wade/Angliss)
5:20pm Social and Dinner
After dinner Working groups on stock structure if necessary

Thursday: 9:00-5:30pm

(30 min) Working group report and discussion
(20 min) Habitat and other issues for strategic stocks: suggestions for meeting the required description of other factors that may be causing a decline or impeding recovery of a strategic stock, including effects on marine mammal habitat and prey (Discussion: Eagle)

PBR calculations: monitoring over multiple years
(30 min) Sampling Implications of the Performance of Marine Mammal By-Catch Management Based on "Potential Biological Removals" (Presentation: Palka)
(30 min) Detecting mortality levels that will lead to depletion, with implications for monitoring frequency and interpretation of the mortality/PBR ratio (Presentation: Wade)
(20 min) Break (10:50-11:10)
(30 min) Monitoring kill of marine mammals computer demonstration (Group exercise: Wade)
(10 min) Combining estimates: weighted means and their CVs (Presentation: Palka)
(20 min) "Aging" of PBR when no new data is available (Presentation and discussion: Hobbs)
(70 min) Lunch (12:00-1:10)
(40 min) Guidelines for combining abundance and mortality estimates, and for monitoring frequency (Discussion: Laake)

PBR Calculations: Detailed Guidelines
(10 min) Calculating the CV of a product (e.g., combining the CVs of an abundance estimate and its associated correction factor (Presentation and discussion: Laake)

(30 min) Calculating PBRs for multiple species/stock complexes (such as beaked whales) (Discussion: Waring/Barlow)
(30 min) Calculating PBR for declining populations (Discussion: DeMaster)

(20 min)	Break (3:10-3:30)
(30 min)	Recovery factors for endangered whales (Discussion: Beach/Lagomarsino)
(30 min)	Correction factors for deep-diving whales (Presentation and discussion: Barlow)
(30 min)	(maybe) Correction factors for pinnipeds, haul-out counts and pup counts (Mathews paper)
(30 min)	Free time for working groups, or to catch up on business
5:30pm	Dinner
After dinner	Working groups if necessary

Friday: 8:00-12:00am

(30 min)	Working groups report and discussion

The annual process for assessing marine mammal stocks

(40 min)	Annual schedule for the stock assessment process (Presentation and discussion: Wade/Angliss)
(20 min)	Break (9:30-9:50)
(40 min)	Review and Revision rules (Discussion: Wade).
(10 min)	Publication issues (Discussion: Eagle)
(10 min)	Target guidelines for the availability of reports on which the SAR estimates are based
(20 min)	SRG role (Discussion: Wade)

Wrap-up

(30 min)	Discussion of assignment of further tasks, including workshop report.
11:40am	End

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Appendix IV. GAMMS workshop documents

Working Papers

Taylor, B. 1995. Defining "populations" to meet management objectives. NMFS-SWFSC Ad Min LJ-95-03 (also in press as NOAA Tech. Rep.). GAMMS-WP-1

Taylor and Dizon. 1996. The need to estimate power to link genetics and demography for conservation. Conservation Biology. In press. GAMMS-WP-2

Draft annual schedule for the stock assessment process (Wade/Angliss). GAMMS-WP-3

Draft Scientific Review Group Plan (Wade). GAMMS-WP-4

Atlantic Scientific Review Group report excerpt. GAMMS-WP-5

Alaska Scientific Review Group report excerpt and letter from L.Lowry. GAMMS-WP-6

Pacific Scientific Review Group excerpt. GAMMS-WP-7

Mathews, E.A. Marine mammal stock assessment reviews: comments on the use of correction factors in calculations of N_{min}. GAMMS-WP-8

Palka, D. and Smith, T Sampling Implications of the Performance of Marine Mammal By-Catch Management Based on "Potential Biological Removals". GAMMS-WP-9

Wade. The probability of correctly detecting a level of human-caused mortality great enough to cause the depletion of a marine mammal population. GAMMS-WP-10

Background Papers

Wade. Calculating sustainable thresholds for the human-caused mortality of cetaceans and pinnipeds. To be submitted to Marine Mammal Science. GAMMS-BP-1

Lerczak, Hobbs, and DeMaster. Incorporating uncertainty in maximum kill levels for long-lived vertebrates. Submitted to J. Wild. Manag. GAMMS-BP-2

Mangel et al. 1996. Principles for the conservation of wild living resources. Ecological Applications. In press. GAMMS-BP-3

Taylor, Chivers, and Dizon. Using geneteic data to define management units for marine mammals. Submitted as NOAA Tech. Rep. GAMMS-BP-4

Perrin and Brownell. 1994. A brief review of stock identity in small marine cetaceans in relation to assessment in driftnet mortality in the North Pacific. Rep. Int. Whal. Commn (Spec Iss 15):393-401. GAMMS-BP-5

Barlow, Swartz, Eagle, and Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73p. GAMMS-BG-6 (not provided to NMFS/SRGs as they should already have one - will be available at workshop)

Gerrodette, T. Draft Ad Min report. A comparison of mortality limits for eastern tropical Pacific dolphins under the declaration of Panama and under Potential Biological Removal (PBR) management. GAMMS-BP-7

Appendix V. GAMMS workshop list of participants

NMFS
Doug Beach (NER)
Gordon Waring (NEC)
Debra Palka (NEC)
Kathy Wang (SER)
Larry Hansen (SEC)
Irma Lagomarsino (SWR)
Jay Barlow (SWC)
Susan Chivers (SWC)
Andy Dizon (SWC)
Barbara Taylor (SWC)
Brent Norberg (NWR)
Bridget Mansfield (AKR)
Linda Shaw (AKR)
Douglas DeMaster (AKC)
Scott Hill (AKC)
Rod Hobbs (AKC)
Jeff Laake (AKC)
Tom Loughlin (AKC)
Robyn Angliss (F/PR)
Tom Eagle (F/PR)
Paul Wade (F/PR)

Non-NMFS
Carl Benz (FWS-Ventura)
Carol Gorbics (FWS-Anchorage)
Judy Zeh (Mar. Mam Commission)
Solange Brault (Atlantic SRG)
John Heyning (Pacific SRG)
Jan Straley (Alaska SRG)
Carl Hild (Alaska SRG)
Joe Blum (Alaska SRG)

Draft February 13, 1997

Appendix VI. GAMMS workshop working group meeting: definition of mortality and serious injury

Participants:

Joe Blum	Bridget Mansfield
Doug Beach	Kathy Wang
Larry Hanson	Debbie Palka
Solange Brault	Robyn Angliss

The working group recommended the following:

- Instead of deciding which injuries are serious, assign a probability that an injury will be serious to each injury as defined in the 118 regulations.
- Conduct research to better determine the probability that an injury would be serious. Current studies that could address this issue are 1) photographs of scars collected during photo-id studies, 2) retrieval and sampling of carcasses resulting from the drift gillnet fishery (NEC study).
- Include the following table in each SAR[5]:

Fishery	**# killed**	**# injured**	**# released alive & uninjured**
Fishery X	observed/ extrapolated	describe injuries	
Fishery Y	observed/ extrapolated		

If killed plus injured is > than PBR, the SAR should make a general statement about the importance of the number of injured animals in a management context.

- What is the most appropriate forum to address the definition of serious injury?
  - -- GAMMS Workshop
  - -- MMPA Task Force
  - -- Separate workshop: HQ funded?
    - -- goals of workshop: 1) information transfer
      2) definition of serious injury

[5]The working group recommended that this table be included. Recommendations endorsed by the GAMMS workshop participants are detailed at 5.1 and 5.2 of the workshop report.

3) research ideas
4) improve field data collection
   -- observer data consistency
   -- stranding data

-- workshop should be held between late summer - mid-September to allow for research priorities to be accounted for in the 1997 FY budget cycle

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Appendix VII. Scientific Review Groups: proposed plan

Scientific Review Groups: a summary of their purpose, structure, and future role

I. Overview:

NMFS must consult with the Secretary of the Interior, the Marine Mammal Commission, Governors of affected adjacent coastal States, regional fishery and wildlife management authorities, Alaska Native organizations, Indian tribes, and resource user (fishing industry and environmental) groups and appoint members to each of three Scientific Review Groups (Pacific, including Hawaii; Atlantic, including the Gulf of Mexico; Alaska). The groups will advise the Secretary regarding the following information:

(a) information in stock assessment reports,
(b) uncertainties and research needed regarding information on marine mammal stocks and the impact of fishing operations on these stocks,
(c) research needed to identify appropriate gear technology to reduce incidental mortality and injury of marine mammals,
(d) the actual, expected, or potential impacts of habitat destruction on marine mammal stocks, and, for strategic stocks, appropriate conservation or management measures to alleviate such impacts, and
(e) other issues that the Secretary or groups consider appropriate.

Members of the groups must have expertise in marine mammal biology and ecology, populations dynamics and modeling, commercial fishing technology and practices, or marine mammal stocks taken under MMPA Sec. 101(b) (the Alaska Native exemption).

There are three Scientific Review Groups (SRGs) consisting of approximately 11 members each. These groups are convened and organized out of each of the following Science Centers: Alaska, Southwest and Northeast/Southeast. These Centers are responsible for contacting SRG members when meetings are to be held, identifying and coordinating lodgings and travel accommodations, providing materials requiring SRG consultation, and assisting in facilitating communication between SRG members and documentation of recommendations. NMFS, through the Centers, will provide travel, hotel and meeting-location expenses. Headquarters budgeted $30K for each team in the first year (FY95) and $20K in the second year (FY96).

In their first year of existence, the SRGs reviewed proposed guidelines for stock assessment reports and the reports themselves. In doing so, the SRGs have advised on marine mammal stock structure, population estimates, population status and trends, annual removals, and uncertainties in available information and data. Now that the first round of stock assessments (1995) have been completed, it is time to establish what the role of the SRGs will be in FY96 and beyond. This includes some logistical issues such as how often the groups should meet and how long members should serve. Therefore, at this point it is desirable to attempt to formalize the expected future role of the SRGs and their interaction with NMFS. The SRGs were established for specific purposes that are outlined in the MMPA. Therefore, it is important for the agency to make recommendations to the SRGs as to how they can most effectively help the agency implement the PBR-based management scheme defined by the 1994 amendments to the MMPA. It is also recognized that the SRGs are specifically identified in the MMPA as independent review groups, and it is further noted that the MMPA states that the groups shall advise the Secretary on any issue which the Secretary or the groups consider appropriate.

The following is a list of recommendations that the agency will make to the SRGs to define their future role.

(1) Review of revised stock assessments.
This role will continue. Stock assessments are required to be revised (a) annually for strategic stocks, (b) annually for stocks with significant new information, and (c) at least once every 3 years for all other stocks.

(2) Review of any changes to the PBR/Stock assessment guidelines
The SRGs provided such a review at the Seattle joint SRG meeting. This role will continue. The SRGs will be asked to review and comment on future changes to the guidelines.

(3) Prioritized list of recommended research to improve the stock assessments.
The SRGs should provide to their NMFS coordinator a written list of recommended research, ranked in order of importance. The three SRGs have to some extent provided this advice already, whether verbally during meetings or in written form in meeting reports. It is proposed that this be made more formal, where each SRG would be requested to provide a written list of recommended research in their meeting report. Such a list is most useful to the agency if the various research areas are ranked in order of importance, or at least put into ranked bins of importance. These recommendations have and will be useful to the agency, both for program reviews at the Centers and for the allocation of MMPA research funds annually.

(4) Review of research recommended in take reduction plans.
The SRGs are asked to advise on "research needed to identify modifications in fishing gear and practices likely to reduce the incidental mortality and serious injury of marine mammals in commercial fishing operations". The take reduction plans that result from the take reduction teams are likely to contain recommendations for research on bycatch reduction measures. The SRGs should review these take reduction plans to stay informed, and it may be appropriate for them to comment on the plans. Specifically, as a SRG, they should comment on research recommended in the Take Reduction Plans. The SRGs may not consider it necessary for all their members to review every take reduction plan, as there may be considerable overlap of people between the take reduction teams and the SRGs. In such a case, an explicit SRG review of the take reduction plans may be unnecessary. In conclusion, NMFS should request that the SRGs

review take reduction plans and comment on research recommended in the plans.

(5) Identify important habitat issues.
The SRGs are asked to advise on "the actual, expected, or potential impacts of habitat destruction, including marine pollution and natural environmental change, on specific marine mammal species or stocks, and, for strategic stocks, appropriate conservation or management measures to alleviate such impacts". They could accomplish this task by identifying important habitat issues for protecting strategic stocks.

This is a fairly broad charge to the SRGs, and it is hard to suggest specific topics on this subject that would be useful for the SRGs to evaluate. However, the Marine Mammal Commission's comments on the draft stock assessments (Dec 1, 1994) do contain numerous references to needing more information on habitat issues, and Sec. 117 does state that the stock assessments should contain information on "...other factors that may be causing a decline or impeding recovery of the stock, including effects on marine mammal habitat and prey". Therefore, a specific task that could be requested of the SRGs would be to identify important habitat issues for strategic stocks. Actually, this may not take long. Presumably, any ESA or MMPA listed stock should have habitat issues addressed in their recovery/conservation plan, but no plan exists for several species. However, in some circumstances it may be useful to get the SRGs perspective on these habitat issues. Certainly, non-listed strategic stocks with human-caused mortality greater than PBR (or listed stocks that do not have a recovery/conservation plan in place or in draft form, or for stocks currently declining but not listed) would benefit from a consideration of important habitat. For such stocks that have a known or suspected source of mortality other than fisheries interaction or subsistence harvest, the SRGs could attempt to identify important habitat to protect that could prevent such mortality.

(6) Logistics
a.) 1-2 meetings per year for each complete SRG is appropriate and may be sufficient, but flexibility should be allowed when issues warrant further attention. Meetings of subgroups may be needed to address specific issues.

In the first year of their existence, the three groups met 2 or 3 times each. However, one meeting was devoted entirely to reviewing the PBR guidelines. Although these are certain to be modified in the future, they are unlikely to require such extensive review in the future. Furthermore, the groups spent the bulk of the rest of their time reviewing stock assessments. This workload should be somewhat less in the future as there will not be 153 new assessments to review each year, and even many of the revised assessments may actually change very little. Therefore, one meeting per year may be sufficient, and 2 meetings per year is certainly appropriate and probably useful. Three meetings in a fiscal year may be necessary at times, as needs arise, particularly if a group has not met for several months prior to the start of a new fiscal year.

b.) Members should have open-ended tenures.

Although it might be desirable to have a limited tenure to gain even broader representation on the groups over time, the reality is that there is limited expertise in certain areas, so it is not clear that it would be desirable to replace all 10-12 members at some point in the future. It may be desirable to rotate a few new people in occasionally to broaden the representation. For now, most people seem fairly satisfied with the composition of the groups.

c.) When replacement members are needed, the SRGs should submit recommendations for replacements to their coordinator. If the relevant Centers and Regions have suggestions for replacements, they should ask the SRGs to comment on those nominees, also.

The power to appoint people to the SRGs clearly resides with the Secretary, who is supposed to consult a long list of people before making their decision. However, it is a reasonable courtesy to ask the SRG for suggestions for replacements, given that they will be the ones who have to work with the new members, and they may have a better idea than anyone else about what kind of expertise they are most lacking and that they would like to have represented on the group.

(7) Reports and minutes of SRG meetings.

For the SRGs to be effective, their advice should be provided in a written form in a timely fashion. SRG meetings usually include NMFS personnel from Science Centers who are responsible for writing stock assessment reports and/or personnel who have done the research that goes into the stock assessment reports. Specific advice relevant to stock assessment reports has been (and should continue to be) provided verbally at meetings and in reports communicated to the NMFS contact person. It is also important for the advice of the SRGs to be communicated more broadly to the agency. Therefore, it is also requested that SRG reports and minutes continue to be provided to the F/PR SRG contact. F/PR will take responsibility for distributing the reports to a broader audience within NMFS, including Regional Directors and Science Center Directors.

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Appendix XIII. Proposed annual schedule for the review and revision of stock assessment reports.

The following schedule ensures that final Stock Assessment Reports (SARs) are available for the development of the proposed List of Fisheries for the upcoming year. Thus, the List of Fisheries for 1998, which is developed during 1997, will be based on marine mammal abundance and incidental mortality information through 1995. Including more recent marine mammal abundance and incidental mortality information is not possible as it requires 1 year to analyze survey information and collect and analyze mortality information from observer programs.

June - Sept.	Prepare draft SARs. Centers are responsible for coordinating reviews by the Regional offices.
September 21	Draft PBR table information due at F/PR.
October 1	FR notice of availability published, including draft PBR table. Public comment period starts (90 days).
	Draft SARs completed and distributed to SRGs, MMPA task force members, and HQ for review. It is anticipated that prior to this date, an initial in-house review of information to be included in the SARs would have taken place involving the appropriate center and regional personnel. Ideally, preliminary abundance and mortality estimates from the previous summer field season will be available by this time (leaving 9 months for preliminary analysis of mortality data, probably over a year for abundance data).
	[Preliminary mortality estimates may suggest revisions to the LOF, which can initiate initial discussions of such changes within NMFS.]
Oct-Dec.	SRG review of draft SARs. Optionally, SRG meetings with NMFS SAR authors to discuss draft SARs.
	HQ organizes NMFS technical review of draft SARs.
	[Any preliminary mortality estimates which become available which suggest a change is needed to LOF should be passed along as soon as possible to regional offices, MMPA task force, and HQ LOF contact.]
Jan 1	SRG and HQ review and comments due to SAR authors.
	Public comment period ends.

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Jan 7	F/PR distributes public comments to SAR authors and SRGs.
Feb 1	Revised PBR/Mortality table information due at F/PR. F/PR assembles table and distributes nationally within NMFS. Ideally, final abundance and mortality estimates from the previous year (leaving 13 months for analysis of mortality data, probably longer for analysis of abundance data) will be incorporated into these revised PBR/Mortality estimates. [Draft List of Fisheries can be constructed at this point, leaving 8 weeks to accomplish before April 1 publication]
Feb 15	Revised SARs (draft final) due incorporating comments from public, SRGs, and NMFS HQ and regions. The expectation is that the final published SAR will not differ substantially from this version. Revised SARs distributed back to SRGs, MMPA task force, and HQ for final inspection of incorporation of comments.
March 15	Final PBR/Mortality table information due at F/PR.
April 1	SARs finalized, due at F/PR for availability for distribution to public. FR notice of availability published with final PBR/Mortality table. Final SARs submitted to publication process (possibly as NOAA tech memos). [Proposed LOF for next year based on final SARs published in FR for public comment. Necessary deadline to meet Oct. 1 finalization deadline.]
April-Oct	[LOF review process]
October 1	[LOF finalized, published in FR. Necessary deadline to allow sufficient time for registration process by end of calendar year.]

Appendix IX. Statistical formulas and background

Coefficient of Variation (CV)

The CV of an estimate is simply the standard error of the estimate divided by the estimate itself. The CV of an estimate ($\hat{x}$) is:

$$CV(\hat{x}) = \frac{Se(\hat{x})}{\hat{x}} \quad ,$$

where Se($\hat{x}$) is the standard error of the estimate. Note that:

$$Se(\hat{x}) = \sqrt{var(\hat{x})} \quad .$$

Therefore, the squared coefficient of variation, CV^2, is simply:

$$CV^2(\hat{x}) = \frac{var(\hat{x})}{\hat{x}^2} \quad .$$

Variance of the product of a constant and a variable

The variance of the product of a constant (c) and an estimated variable ($\hat{x}$) is the square of the constant multiplied by the variance of the estimate:

$$var(c*\hat{x}) = c^2*var(\hat{x}) \quad .$$

Variance of the sum of two independent variables

The variance of the sum of two variables is simply the sum of their variances (if they are independent):

$$var(\hat{x}_1+\hat{x}_2) = var(\hat{x}_1)+var(\hat{x}_2) \quad .$$

For example, when summing mortality estimates from two fisheries, the variance of the sum is just the sum of the variances. The standard error (square root of the variance) of the sum can then be converted into a CV of the sum by dividing it by the sum.

Variance of the un-weighted mean of several variables

The mean of several variables can be thought of as the sum of those variables multiplied by a constant (i.e., 1/n), so that the variance of such a mean can be calculated from combining the two above equations. Therefore, the variance of the mean of several estimates is the sum of their variances divided by the square of the number of estimates:

$$r(mean\ of\ \hat{x}_1, \hat{x}_2, \ldots) = \frac{var(\hat{x}_1)}{n^2} + \frac{var(\hat{x}_2)}{n^2} + \ldots \frac{var(\hat{x}_n)}{n^2} = \sum_{i=1}^{n} \frac{var(\hat{x}_i)}{n^2}$$

This is the formula that can be used, for example, to calculate the variance of the mean mortality of a single fishery across several years.

Weighted mean of several estimates and its associated variance

The weighted mean of several estimates is calculated by summing the products of the estimates and their respective weights, and dividing the total by the sum of the weights. For example, using the inverse of the respective variances as the weights results in:

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

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

The variance of a weighted mean of several estimates will be the sum of the variances multiplied by the square of the weights. For example, a weighted mean using the inverse of the estimated variances as the weights will have as its variance:

$$var(mean\hat{x}_1, \hat{x}_2, \ldots \hat{x}_n) = w_1^2 var(\hat{x}_1) + w_2^2 var(\hat{x}_2) + \ldots w_n^2 var(\hat{x}_n) = \sum_{i=1}^{n} w_i^2 var(\hat{x}_i)$$

$$= \sum_{i=1}^{n} \left(\frac{\frac{1}{var(x_i)}}{\sum_{j=1}^{n} \left(\frac{1}{var(x_j)} \right)} \right)^2 var(x_i) = \frac{1}{\sum_{j=1}^{n} \frac{1}{var(x_j)}}$$

A weighted mean should be used for combining more than one abundance estimate into a single abundance estimate.

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Variance of a product of independent estimates (approximate)

An approximate variance for a product or ratio can be derived by the delta method which is based on a second order Taylor series expansion. See pages 7-9 in Seber(1973) for a derivation of the delta method. For a product of independent random variables an estimator for the exact variance is also available (Goodman 1960) but the approximation is sufficiently close in most situations. For products and ratios, a simplification is achieved by expressing the variance formula in terms of coefficient of variation (CV). Using the above notation for the product($\hat{x}\,\hat{y}$) and ratio($\hat{x}/\hat{y}$) of independent estimates, the delta method approximations for the $CV^2(\hat{x}\,\hat{y})$ and $CV^2(\hat{x}/\hat{y})$ are identical and expressed as:

$$CV^2(\hat{x}\hat{y}) = CV^2(\hat{x}/\hat{y}) = CV^2(\hat{x}) + CV^2(\hat{y}) \quad .$$

Therefore, the CV of a product can be calculated as:

$$CV(\hat{x}\hat{y}) = \sqrt{CV^2(\hat{x}) + CV^2(\hat{y})} \quad .$$

It can also be expressed in terms of the variances. Using the definition in (1), we get:

$$var(\hat{x}\hat{y}) = CV^2(\hat{x}\hat{y})\,\hat{x}^2\hat{y}^2 = var(\hat{x})\,\hat{y}^2 + var(\hat{y})\,\hat{x}^2 \quad ,$$

and likewise,

$$var(\hat{x}/\hat{y}) = CV^2(\hat{x}/\hat{y})\,\frac{\hat{x}^2}{\hat{y}^2} = \frac{var(\hat{x})}{\hat{y}^2} + var(\hat{y})\,\frac{\hat{x}^2}{\hat{y}^4} \quad .$$

The formula for calculating the variance of a product is useful for calculating the variance for a single abundance estimate that has been multiplied by a correction factor. If the values being multiplied are statistically independent, then it can be seen above that the CV of the product is the square root of the sum of the squared individual CV's of each component, such as the CV of the un-corrected abundance estimate and the CV of the correction multiplier.

Variance of a product of independent random variables (exact)

For a product of independent random variables, the estimator for the variance (Goodman 1960) is:

$$\hat{var}(\hat{x}\hat{y}) = \hat{var}(\hat{x})\, \hat{y}^2 + \hat{var}(\hat{y})\, \hat{x}^2 - \hat{var}(\hat{x})\, \hat{var}(\hat{y}) \quad ,$$

which can also be expressed in terms of squared CV's as:

$$CV^2(\hat{x}\hat{y}) = CV^2(\hat{x}) + CV^2(\hat{y}) - CV^2(\hat{x})\, CV^2(\hat{y}) \ .$$

The estimator derived by Goodman (1960) is often incorrectly given with an addition of the product of variances rather than a subtraction. This error is made because it should be added for the variance of a product of independent variables but for the **estimator** of the variance it must be subtracted. However, as shown below, if either the CV($\hat{x}$) or the CV($\hat{y}$) is less than 0.3, the approximation given in (2) is only slightly larger (<4%) than (3) if the estimates are truly independent.

Ratio of equations (2) and (3) for various combinations of CV for $\hat{x}$ and $\hat{y}$.

	CV(x)									
CV(y)	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1**
0.1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.2	1.00	1.01	1.01	1.02	1.02	1.02	1.02	1.02	1.02	1.02
0.3	1.00	1.01	1.02	1.03	1.03	1.04	1.04	1.04	1.04	1.04
0.4	1.00	1.02	1.03	1.04	1.05	1.06	1.07	1.07	1.07	1.08
0.5	1.00	1.02	1.03	1.05	1.07	1.08	1.09	1.10	1.11	1.12
0.6	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.15	1.17
0.7	1.00	1.02	1.04	1.07	1.09	1.12	1.15	1.18	1.20	1.22
0.8	1.00	1.02	1.04	1.07	1.10	1.14	1.18	1.21	1.25	1.28
0.9	1.00	1.02	1.04	1.07	1.11	1.15	1.20	1.25	1.30	1.35
1	1.00	1.02	1.04	1.08	1.12	1.17	1.22	1.28	1.35	1.41

Variance of a product of correlated random variables

A direct application of the delta method for products and ratios in which $\hat{x}$ and $\hat{y}$ are correlated yields the following formulas expressed in terms of CV^2:

$$CV^2(\hat{x}\hat{y}) = CV^2(\hat{x}) + CV^2(\hat{y}) + 2\rho\, CV(\hat{x})\, CV(\hat{y}) \quad ,$$

and

$$CV^2(\hat{x}/\hat{y}) = CV^2(\hat{x}) + CV^2(\hat{y}) - 2\rho\, CV(\hat{x})\, CV(\hat{y}) \quad ,$$

where ρ is the correlation between $\hat{x}$ and $\hat{y}$.

Literature Cited

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