Report of a Workshop on Developing Recovery Criteria For Large Whale Species

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REPORT OF A WORKSHOP ON DEVELOPING RECOVERY CRITERIA FOR LARGE WHALE SPECIES

EXECUTIVE SUMMARY

The National Marine Fisheries Service (NMFS) convened a workshop in Seattle Washington on 26-27 February 2001 to develop recovery criteria for large whale species listed as "endangered" under the Endangered Species Act (ESA). Recovery criteria[1] are an ESA-required component of recovery plans. Because some populations of endangered large whale species have grown in abundance, they may be candidates for a change in status from endangered to threatened, or removal from the List of Threatened and Endangered Wildlife. NMFS has not developed and adopted recovery criteria for most of these taxa.

Workshop objectives were to develop (a) a general framework for the development of recovery criteria that would be applicable to most marine mammal species, large whale species in particular, and (b) specific criteria that can be used to apply the framework to specific populations. A major goal was to use North Pacific and North Atlantic right whales as case studies, and to develop a specific set of recovery criteria which could be used for these populations.

The workshop reviewed the legislative and regulatory history of recovery criteria for listed species. It considered criteria included by NMFS and the U.S. Fish and Wildlife Service (FWS) in recovery plans for various species of marine mammals, and heard and discussed presentations on recent work by NMFS to develop a more robust approach to recovery criteria. Based on these discussions, workshop participants concluded that the general framework for recovery criteria developed for large whales should:

- be developed and applied at the Distinct Population Segment (DPS)[2] level;
- be defined by the risk of extinction;
- be probabilistic;
- use a Population Viability Analysis (PVA) approach/philosophy; and
- explicitly identify the acceptable risk and the time frame of consideration.

[1] For the purposes of this report, "recovery criteria" refer to criteria developed in order to change the status of a species from endangered to threatened, or to remove a species from the List of Endangered and Threatened Wildlife and Plants (List) under the ESA. Similarly, for the purposes of this report, "recovered" refers to removal from the List, i.e., no longer listed as endangered or threatened under the ESA.

[2] A DPS is defined for vertebrate species as a population segment that is discrete and significant in relation to the remainder of the species to which it belongs (61 FR 4722; 7 February 1996).

Using this framework, the workshop developed the following specific criteria to be applied to large whales:

- A large cetacean DPS shall no longer be considered endangered when, given current and projected conditions, the probability of extinction is less than 1% in 100 years; and
- A large cetacean DPS shall no longer be considered threatened when, given current and projected conditions, the probability of becoming endangered is less than 10% in a period of time no shorter than 10 years and no longer than 25 years, with the period depending on the volatility of the dynamics of the population, the power of the monitoring to detect changes, and the expected response time of the management agency. For large whales, the workshop participants determined that an appropriate time interval would be 20 years.
- Threats to the species and recurrence of threats that brought the species to the point that warranted listing have been addressed. The ESA requires that any determination of the status of a species consider five potential sources of threats (or five "factors") affecting its continued existence: (a) the present or threatened destruction, modification, or curtailment of it's habitat or range; (b) overutilization for commercial, recreational, scientific, or educational purposes; (c) disease or predation; (d) the adequacy of existing regulatory mechanisms; and (e) other natural or manmade factors. Clearly, each recovery plan and any consideration to change the listing status of a species must address these five areas.

The workshop recommended that the framework and criteria identified above be institutionalized and be used when NMFS and recovery teams consider changes to a population's listing status and in developing recovery plans. These recommendations are the opinions of workshop participants and are forwarded to NMFS managers for consideration in establishing or modifying agency policies regarding objective, measurable recovery criteria for large whales.

INTRODUCTION

The U.S. Endangered Species Act (ESA) of 1973 requires that recovery plans be developed for all species listed as "endangered" or "threatened" under the Act. Amendments to the ESA in 1988 added the requirement that all recovery plans include specific criteria for removing, or "de-listing"[3], species from the List of Endangered and Threatened Wildlife and Plants (List) under the ESA. Quantitative criteria for listing or de-listing species were not provided as part of the ESA and its amendments. The National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (FWS) have not prepared a protocol for quantitative evaluation of a species' status under the ESA. This contrasts with the relatively rigorous set of criteria developed by NMFS for implementation of the Marine Mammal Protection Act's 1994 amendments (Wade and Angliss 1997).

Without an agreed set of criteria for evaluating the status of species under the ESA, it has been difficult for NMFS to systematically determine the status of some marine species, large whales in particular. Both the development and application of criteria are problematic for large whales due to a paucity of data on abundance, trends in abundance, and the level of adverse effects from human activities. However, because recovery plans for several large whale species are currently being revised and because the size of some populations of some large whale species have increased considerably since the early 1970s, it is incumbent upon NMFS to develop a framework that can be used to specify recovery criteria for large whales. NMFS convened a workshop in Seattle, Washington, on 26-27 February 2001, to discuss development of recovery criteria for large whales and, if possible, to apply that framework to a large whale species. This is a report of that workshop. The workshop agenda and a list of participants are provided as Appendices I and II. A list of background materials is provided as Appendix III.

The conclusions and recommendations in this report are opinions of workshop participants and do not represent NMFS policy. This report includes recommendations to NMFS managers for consideration in establishing or modifying agency policies regarding objective, measurable recovery criteria for large whales.

LEGISLATIVE AND REGULATORY HISTORY

Endangered Species Act

The ESA provides limited guidance on criteria by which to determine whether a species shall be considered as endangered or threatened. Section 3 (6) of the Act as amended through 1988 defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range", while Section 3 (20) defines a threatened species as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion

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[3] "De-listing" refers to the removal of a species from the List of Endangered and Threatened Wildlife and Plants under the ESA. Two related terms, "down-listing" and "up-listing", are also used in this report, and refer to the change in status from endangered to threatened, and from threatened to endangered, respectively.

of the range". Section 4 (a) (1) of the Act, entitled "Determination of Endangered Species and Threatened Species" identifies factors that should be considered when making a decision to list (or de-list) a species, namely threats from:

(1) the present or threatened destruction, modification, or curtailment of its habitat or range;
(2) overutilization for commercial, recreational, scientific, or educational purposes;
(3) disease or predation;
(4) the inadequacy of existing regulatory mechanisms; or
(5) other natural or manmade factors affecting its continued existence.

Section 4 (f) of the ESA requires that a recovery plan be developed for each species listed as endangered or threatened under the Act, unless a determination is made that developing such a plan will not promote recovery of the species. This section also requires that the recovery plan include "objective, measurable criteria" which, when met, would lead to the conclusion that the species is no longer endangered or threatened. Subsequent case law has made it clear that the five potential sources of threats listed above shall also be considered when developing de-listing criteria within the recovery plan for the species (Fund for Animals v. Babbitt, 903 F. Supp 96 [D.D.C. 1995]). Particular attention must be given to any of the factors implicated in the original listing decision.

Independent reviews (e.g., Easter-Pilcher 1996; Tear *et al*. 1995) of listing decisions made by the FWS have found little consistency in the criteria used to list species under the ESA. Despite inclusion of de-listing criteria in many recovery plans, participants in the workshops convened by Easter-Pilcher (1996) were unable to identify specific efforts by any organization to develop consistent frameworks or criteria. Easter-Pilcher (1996) also found that there was not adequate justification for previously published listing criteria under the ESA. Therefore, workshop participants could not defer to models or precedence set by U.S. agencies or organizations. Certain international organizations have struggled with methods of classifying species according to the levels of risk, notably the International Union for the Conservation of Nature (IUCN), and the Convention for International Trade in Endangered Species (CITES). The Canadian model for dealing with endangered species conservation through the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the *National Accord for the Protection of Species At Risk* (1996) was not addressed directly in the workshop, as its protocols were already considered in the discussion of the ESA and/or IUCN/CITES approaches.

International Union for the Conservation of Nature (IUCN)

Criteria developed by the IUCN are modified after those proposed by Mace and Lande (1991) and classify species at risk into three categories: "critically endangered", "endangered", and "vulnerable". The first two categories are considered roughly equivalent to the ESA's "endangered" category, while the "vulnerable" category is roughly synonymous with "threatened" under the ESA. Five different criteria have been developed for evaluating status under each category (Appendix IV). A species is assigned to a category if it meets any of the criteria specific to that category. The criteria have been applied to a wide array of terrestrial and marine animals, plants, and micro-organisms (e.g., all known mammal species have been classified). They have been adopted by most nations (other than the U.S.) participating in the IUCN.

The workshop identified at least three reasons why the IUCN criteria are inadequate as a model for recovery criteria under the ESA:

(1) the criteria use a "one size fits all" approach, which may not be appropriate for marine species;
(2) the criteria considers the risks to species at the global level, and does not allow classification of discrete populations unless the entire species has already been classified into a risk category; and
(3) the criteria may be too precautionary because of the inability of the criteria to handle separate populations in lieu of global species (thus, the status of all populations of each species is determined using the data on the most at-risk population).

The American Fisheries Society also considers the IUCN approach inappropriate for dealing with marine fishes and has proposed an alternative approach for dealing with fish species at risk (Musick 1999).

Convention for International Trade in Endangered Species

Listing criteria developed by CITES classify species at risk into one of two appendices (i.e., Appendix I for the "most endangered species" and Appendix II for "other species at serious risk"). Classification is based on the IUCN criteria. Workshop participants generally agreed that the CITES classification criteria were not directly relevant to this workshop. A second NMFS working group (chaired by Dr. Pamela Mace) reviewing the applicability of CITES/IUCN criteria to the de-listing process has concluded that these criteria are difficult to apply to marine species.

DEVELOPING CRITERIA FOR MARINE SPECIES

Since enactment of the ESA, NMFS and FWS have used a variety of approaches to determine delisting criteria for marine species. Large whale species have been particularly problematic because they have enormous ranges, are difficult to count, have unusual life histories, and may consist of multiple species or populations.

Examples of previous approaches to de-listing are presented in the following sections.

Pacific Salmon

NMFS and the FWS are currently developing recovery plans for listed salmonids in the Pacific Northwest. Although recovery criteria have not yet been developed, the Technical Recovery Teams have identified abundance, population productivity, genetic diversity, and spatial structure as critical components of recovery criteria (many of these will have to be considered when the five factors required by the ESA are addressed). The Technical Recovery Teams have identified the following options for approaches to recovery criteria: 1) the population on

Box 1: Draft template for recovery criteria for Pacific Northwest Salmonids ESU

"There must be at least __ populations meeting or exceeding the viable population criteria as defined below. These viable populations must be distributed with at least __ viable populations in region __, __ viable populations in region __, etc. There must be at least __ viable populations with life history type __, at least __ populations with life history type __, etc."

average replaces itself, and the mean abundance is greater than or equal to some minimum population size, 2) information on productivity and abundance indicates that the population is viable (e.g., use a population viability analysis, or "PVA", approach), or 3) the population has achieved some fraction of its historic population abundance. When developing recovery criteria for salmon, NMFS biologists believed that, while consideration of the five factors identified in the ESA is important, consideration of these factors is not, in itself, sufficient to justify de-listing.

Workshop participants expressed concern that the approach for specific recovery criteria for a salmonid Evolutionarily Significant Unit (ESU)[4] outlined in Box 1 implies that some viable populations may be expendable. Participants noted that, at this time, NMFS's intent is to conserve all marine mammal populations.

Seabird Recovery Plans

The development of criteria for spectacled eiders (Taylor *et al*. 1996) was also discussed, although it involved the development of classification criteria, not recovery criteria. Taylor *et al*. (1996) used a Bayesian approach to incorporate uncertainty in a variety of parameters, and to generate probabilities of extinction that could be used in a decision analysis framework. The approach required data on abundance and trends in abundance, and would be useful if such data are available for a particular species. This approach had the following benefits: 1) multiple types of data could be used, 2) the model generated probability distributions that allowed examination of the relative probabilities of under- or over-protection, and 3) the approach resulted in an estimate of the minimum viable population level, which could be used as a trigger for management action.

Marine Mammal Recovery Plans

Recovery plans have been completed for six of the eleven listed marine mammal species. Recovery criteria in the six recovery plans were reviewed and no consistent approach has been used for de-listing or re-classification. In fact, the recovery plans for some large whale species, such as blue whales and a draft plan for sei and fin whales, do not include any recovery criteria.

FWS recently funded a large study that examined the content of recovery plans developed by the FWS and specifically examined recovery criteria (Boersma *et al*.

[4] An Evolutionarily Significant Unit (ESU) for Pacific salmonids is defined by NMFS as "a population or a group of populations that 1) is substantially reproductively isolated from other conspecific units and 2) represents an important component in the evolutionary legacy of the species." (56 FR 58612; 20 November 1991).

in press). Boersma *et al*. (in press) suggested that the species with recovery plans that had biologically-based recovery criteria were more likely to have increasing or stable populations, while species that had recovery criteria not based on the biology of that species tended to not be increasing or stable. Although little interpretation of this finding was provided, it seems a good argument in support of using species-specific, biologically-based recovery criteria.

Criteria included in existing marine mammal recovery plans are described below.

Steller sea lions: NMFS listed the Steller sea lion (*Eumetopias jubatus*) as threatened throughout its range in 1990. A recovery team was formed in 1990 and the team prepared a recovery plan which was published by NMFS in December 1992. Down and up-listing criteria were proposed by the team (Box 2) and are included in the *Final Recovery Plan for Steller Sea Lions, Eumetopias jubatus* (1992). However, only the de-listing criteria were accepted by NMFS. In declining to accept all of the criteria, NMFS noted that it "will evaluate a combination of techniques, like population viability analysis and analysis of data on historical trends, to provide a more robust estimation of the likelihood of extinction". NMFS staff did develop such models (York *et al*. 1996), however, this approach also did not result in acceptable criteria. In general, the Steller sea lion criteria are probably the most thorough, and with the inclusion of the PVA analyses, are likely the most rigorous of criteria included in a NMFS marine mammal recovery plan. Positive elements of the Steller sea lion criteria included the consideration of both threshold abundances and trends, multiple stocks (regions), effects of different life stages on status, and with the PVA analysis, the consideration of a probabilistic approach to risk assessment.

Box 2: Criteria recommended by the Steller Recovery Team

1) if the current Adult/Juvenile Trend Count in the Kenai-Kiska area is less than 17% of the benchmark value, the species should be listed as **endangered**;
2) if the current Adult/Juvenile Trend Count in the Kenai-Kiska area is greater than 17% but less than 40% of the benchmark value, the species should be listed as **threatened**, except:
3) if the current Adult/Juvenile Trend Count in the Kenai-Kiska area is greater than 17% but less than 25% of the benchmark value the species should be listed as **endangered** if one or more of the following situations exists:
   a) the Kenai-Kiska Adult/Juvenile Trend Count has declined by at least 10% over 3 or more consecutive survey years,
   b) the overall Pup Production Index in the Kenai-Kiska area has declined by 10% over the count in the previous 2-year block
   c) the number of animals has declined by at least 10% over a three-year period since 1989 in 3 or more of the 6 other regions
4) if the current Adult/Juvenile Trend Count in the Kenai-Kiska area is greater than 40% of the benchmark value of 90,000 nonpups, and the number of animals is stable or increasing in at least 3 of the 6 other regions, then the species should be **de-listed**.

In 1997, NMFS changed the classification of the species by separating it into two DPS based on demographic and genetic dissimilarities: the status of the eastern DPS (Southeast Alaska through California) remained as listed as threatened, but the western DPS (Prince William Sound, Alaska westward) was re-classified as endangered.

Northern right whales: Northern right whales (*Eubalaena glacialis*), like other baleen whales, were on the initial list of endangered species. No explicit criteria were considered for this initial listing. A recovery team was formed in 1991, and the team prepared a recovery plan which included down-listing criteria. The criteria required that the size of the North Atlantic population recover to at least 3,000 animals, that the population increase at a rate of 2%/year for at least 20 years, and that an effective program is in place to control mortality and protect habitat before the population could be down-listed to threatened. No up-listing or recovery criteria were included in the plan, and no criteria were provided for the North Pacific population.

Southern sea otters: The recovery team for southern sea otters (*Enhydra lutris nereis*) generally believed that the population should attain a threshold size before the FWS should consider whether data pertaining to the five factors would support de-listing the stock. Thus, the recovery team developed recovery criteria that were based on the sum of the effective population size (1,850) and the modeled estimate of the number of otters killed by 90% of simulated oil spills (800) (Ralls *et al*. 1996). The recovery team recommended that the FWS consider de-listing southern sea otters only when the three-year running average from the spring count of the population was greater than 2,650 individuals. Criteria were also developed for listing as endangered (three year running average less than 1,850 animals) and threatened (three year running average between 1,850 and 2,650 animals). The recommendations of the recovery team have not yet been incorporated into the recovery plan.

Manatees: The West Indian manatee was first listed in 1967, and a recovery plan was published by FWS in 1980. In 1986, a recovery plan for the Antillean manatee in Puerto Rico was completed; a separate plan for Florida manatees was completed in 1989. The plan for the Florida manatee was revised in 1996 and a revision is planned for 2001. All versions of all of these plans failed to include objective, measurable recovery criteria. Down-listing and de-listing goals for these plans included: an immediate goal of restoring populations to levels that will permit down-listing from endangered to threatened and an ultimate goal of recovering manatees to the point where they could be de-listed. These goals were further conditioned with statements that suggested that "when data and models are available to assess population size and trends, down-listing should be considered when analyses indicate the population is growing or stable, when mortality factors are controlled at acceptable levels or are decreasing, and when critical habitats are secure and threats to them are controlled or decreasing." The current draft of the 2001 Florida Manatee Recovery Plan identifies objective, measurable recovery criteria based on survival rates, number of females with first and second year calves, and an annual population growth rate. It is believed that these benchmarks, in conjunction with addressing the five listing factors, will enable FWS to determine when de-listing should occur.

Hawaiian monk seals: A recovery plan was prepared for this endangered species (*Monachus schauinslandi*) in 1983; however, the plan includes no recovery criteria.

Humpback whales: This species (*Megaptera novaeangliae*) is listed as endangered in both the North Pacific and North Atlantic oceans, and a recovery plan for the species was prepared in 1991. No recovery criteria are provided in the plan.

Blue whales: A recovery plan was prepared for the endangered blue whale (*Balaenoptera musculus*) in 1998; however, the plan indicated only that recovery criteria should be developed.

OBSTACLES TO DEVELOPING RECOVERY CRITERIA

Participants identified two generic types of problems related to development of recovery criteria for large whales: those related to the guidance in the ESA and those related to data available on large whale population status. The ESA provides no guidance regarding what quantifying measures should be used when addressing the five listing factors. In addition, the ESA provides no guidance specific to marine mammals on dealing with population structure. Some marine mammal species are particularly difficult to classify under the ESA because, although the species are listed under the ESA on a global level, many species actually consist of populations which range over immense geographic areas and cross multiple national and management boundaries.

Addressing Population Status

Considerable uncertainty exists regarding the status, abundance, and trends in abundance of most large cetacean species. The following specific challenges were identified:

(1) assessment of stock structures of some species of large cetaceans is difficult using traditional genetic techniques because large populations generally have a low effect size[5]

(2) assessment of current abundance relative to historic abundance is difficult because data on historic abundance are sparse or non-existent for most large cetaceans;

(3) assessment of trends in abundance for large cetaceans typically requires 8-10 years of population monitoring and is very expensive; and

(4) recovery criteria developed for other species tend to be overly simplistic and depend on point estimates of such things as population size, rate of increase, etc., not probabilities. It is not practical to apply this approach to large cetaceans because population estimates are difficult to obtain (due do large geographic ranges) and have low precision, and assessing change in population size is problematic.

Large cetacean species were listed under the ESA in 1970 without developing specific listing criteria. In retrospect, cetaceans listed under the ESA in 1973 clearly fall into two groups: those which truly were at risk of extinction (e.g., right whales) and those which were listed primarily because of concern about the effects of prior exploitation and the inadequacy of

[5] "Population effect size" refers to the amount of genetic difference, in statistical terms, required before a grouping of animals can be designated as one stock or two. Therefore, small, but significant amounts of movement may be difficult to detect (or exclude) in large populations with high genetic diversity.

conservation measures in the early 1970's (e.g., sperm whales). Because the original biological reasons (if any) for listing under the ESA were not documented, it will not be appropriate to do comparative assessments of existing threats relative to historic ones, but assessment of current or projected threats (i.e., the five ESA listing factors) will nonetheless involve assessments of current threats and data.

NMFS has, however, made efforts in the recent past to consider new approaches to development of recovery criteria. A common theme in each of the following cases is that consideration of the five factors is immaterial unless it can first be quantitatively established that the population is no longer in danger of extinction.

Eastern North Pacific gray whales: In 1993, NMFS made a determination to remove the eastern North Pacific stock of gray whales (*Eschrichtius robustus*) from the ESA's List of Threatened and Endangered Wildlife (List) based on strong evidence that the stock had recovered to near its estimated historical population size. In 1994, the Fish and Wildlife Service modified the List, removing the eastern North Pacific gray whale stock. Although no formal recovery criteria were in place when the gray whale was removed from the List, NMFS justified this action based on the large population size relative to historical levels and the fact that a review of the five factors led to the determination that there were no natural or man-made activities which would lead to the species being considered "threatened" or "endangered" in the foreseeable future. The action of de-listing the eastern North Pacific gray whale is unique because 1) it is the only cetacean species de-listed to date, and 2) the gray whale is the only cetacean for which a reasonably reliable estimate of historical abundance exists against which to compare the current population size. The published notice to de-list the population provides an example of the assessment of the five ESA de-listing factors.

Humpback whales: In 1997, the National Marine Mammal Laboratory sponsored a workshop to develop classification criteria for humpback whales. Gerber and DeMaster (1999) used the results of the workshop to develop a quantitative approach to classification under the ESA and applied this approach to North Pacific humpback whales. The approach involved estimating the minimum viable population level for a particular stock, developing a conservative estimate of abundance and trends in abundance, then forecasting the population's trajectory to determine whether the population would be likely to fall below the minimum viable population over a specified time period. This approach requires reliable abundance and trend data and reliable modeling of all factors which may significantly affect population trends. Data on abundance and trends, as well as on pertinent factors, may not be available for many whale species, which increases uncertainty in model results.

Bering-Chukchi-Beaufort stock of bowhead whales: Shelden (1998) advocated a species-specific approach to recovery criteria, and proposed criteria for de-listing the Bering-Chukchi-Beaufort stock of bowhead whales. The approach sets specific population thresholds which must be met to justify down-listing or de-listing, recommends consideration of stock structure and inbreeding depression, and recommends establishment of long-term monitoring and management regulations prior to changes in the conservation status.

Addressing Population Structure

Workshop participants strongly recommended that any general framework for recovery criteria should be sufficiently flexible to allow consideration of recovery of population units smaller than an entire species with a worldwide range. At a minimum, separate units should be designated for each ocean basin because individuals from separate basins likely would not interbreed when mature, and, if a basin population were extirpated, re-colonization would not be likely areas in a period meaningful for management purposes.

NMFS/FWS policy suggests that there are two approaches to dealing with units below the species taxonomic level in recovery plans and criteria: "Distinct Population Segment" and "Recovery Units". In 1978, the ESA was amended to redefine the term "species" to include "any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." Further clarification was provided when NMFS issued a policy in 1991 with regard to applying the definition of "species" under the ESA to Pacific salmonids (56 FR 58612, 20 November 1991). In the policy statement, a "distinct population segment" was equated to an "Evolutionary Significant Unit" (ESU), and an ESU was defined as "a population or a group of populations that (a) is substantially reproductively isolated from other conspecific units and (b) represents an important component in the evolutionary legacy of the species." Subsequently, NMFS and FWS published a policy in 1996 (61 FR 4722, 7 February 1996) on the recognition of distinct vertebrate population segments (DPS) under the ESA. The policy indicates that a population can be considered a DPS if (a) it is discrete, and (b) it is significant. This is similar to and consistent with NMFS' ESU policy in that the first criterion of discreteness parallels the ESU's reproductive isolation criterion; and the second criterion of significance parallels the evolutionary legacy criterion of the ESU definition.

The policy also indicates a population segment of a vertebrate species may be considered discrete if it is:

(1) markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors. Quantitative measures of genetic or morphological discontinuity may provide evidence of this separation; or

(2) delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act.

Further, the policy indicates that if a population segment is considered discrete under one or more of the above conditions, its biological and ecological significance will then be considered in light of Congressional guidance (see Senate Report 151, 96th Congress, 1st Session) that the authority to list DPS's be used "...sparingly" while encouraging the conservation of genetic diversity. In carrying out this examination, the Services will consider available scientific evidence of the discrete population segment's importance to the taxon to which it belongs. This consideration may include, but is not limited to:

(1) persistence of the discrete population segment in an ecological setting unusual or unique for the taxon;

(2) evidence that loss of the discrete population segment would result in a significant gap in the range of a taxon;

(3) evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range; or

(4) evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

The workshop concluded that the DPS approach was potentially useful in describing population structures of large whales, and would ensure that recovery criteria are not applied to an entire worldwide species.

Workshop participants also considered the concept of "Recovery Unit" (RU), which can be a subunit of a species, and is not necessarily the same as a DPS. RUs are described in the NMFS/FWS Consultation Handbook at pages 4-34 to 4-37 as a subunit of species or DPS identified in a recovery plan that are necessary for the survival and recovery of a species. Actions that adversely affect a RU can jeopardize the survival and recovery of the entire species. Only those RUs that can be identified as DPSs may be de-listed or down-listed through a rule-making.

Caution was expressed about equating a "stock" under the MMPA with a DPS under the ESA. According to the MMPA, stocks are "a group of marine mammals of the same species or smaller taxa in a common spatial arrangement that interbreed when mature" and should be conserved as functional units of their ecosystems. In contrast, one goal of the ESA is to conserve species which are important from an evolutionary standpoint. The workshop concluded that the GAMMS workshop report (Wade and Angliss 1997) continue to be used to provide guidance for designating stocks under the MMPA. The agency has already developed an independent approach to designating DPS (61 FR 4722).

GENERAL FRAMEWORK FOR RECOVERY CRITERIA

Workshop participants recommended that NMFS adopt a common framework for recovery criteria that could be applied to each species or large cetacean DPS. As some criteria should be met for all species, and other criteria should be met only by certain species, this framework should be both general and species-specific. Participants agreed that such a framework should include a threshold risk of extinction (or "trigger" mechanism) and that de-listing should not be considered for a given species or DPS if it's risk of extinction is greater than that threshold.

Therefore, after considerable discussion, the workshop concluded that the general framework for de-listing criteria developed for large whales should:

(1) be developed and applied at the Distinct Population Segment (DPS)

level;
(2) be defined by the risk of extinction;
(3) be probabilistic;
(4) use a Population Viability Analysis (PVA) approach/philosophy; and
(5) explicitly identify the acceptable risk and the time frame of consideration.

Having thus agreed, the workshop considered and developed specific criteria, discussed below, and provided recommendations in that regard.

Specific Criteria Should Be Developed and Applied at the DPS Level

Most large cetacean species, such as blue whales, fin whales, and humpback whales, have worldwide distributions. While these species have basin-specific populations, they were initially listed under the ESA as single species. However, developing "global" de-listing criteria would be inappropriate because 1) whales in different ocean basins are not likely to interbreed due to the geographic separation, 2) extirpation of a species in a particular ocean basin is not likely to be followed by re-colonization in a time frame relevant to management, 3) for many species, existing information supports designation of separate populations in different ocean basins, as well as separate populations within some ocean basins, and 4) information on the status of different species is generally specific to smaller, distinct units in lieu of the global population.

As a result of this discussion, *workshop participants recommended that specific recovery criteria be applied at the DPS level*. In addition, workshop participants strongly recommended that the largest reasonable DPS would be the population of a particular species which inhabits an ocean basin, and strongly recommended against attempting to de- or down-listing a species on a worldwide basis.

The Risk of Extinction Should Be Used to Define Criteria

Workshop participants agreed that changes in listing status should be based on the risk of extinction and that the probability that the species would or would not become extinct within a period that is relevant to management. Participants believed that this approach would be most consistent with the ESA's goal of preventing extinction. Using the recommended approach, a species would only be considered "recovered," and thus a candidate for de-listing, when the risk of extinction was "small."

Criteria Should Be Probabilistic

Workshop participants discussed three different types of thresholds or triggers that could be incorporated into recovery criteria for all large whale species: population size, effective population size, and some type of probabilistic threshold.

The workshop recommended that a probabilistic threshold describing the risk of extinction be included in all recovery criteria. This was clearly the preferred approach because:

(1) It is the best, and perhaps only, way to evaluate the risk of extinction as required by the ESA;
(2) Using population size as a trigger was not considered adequate because it failed to provide any information about the trend in population size or whether the population is under

threat of extinction. The size of a population is only one component of an analysis of the probability of the risk of extinction for that population; and

(3) Using the effective population size[6] as a trigger was not considered adequate because it requires information on (or reasonable assumptions about) the proportion of mature individuals in a population. Not only would this be difficult to assess for many species of large cetaceans, but it could also be misleading because the proportion of mature animals in a population will be smallest when the population is increasing.

A PVA Approach/Philosophy Should Be Used for Developing Criteria

Population Viability Analysis, or PVA, is the general term for a demographic model that can be used to inform decision-makers about the viability of certain species, such as those listed as threatened or endangered under the ESA. PVA is a modeling exercise to assess viability that may incorporate, among other things, such factors as life history, population size, age-specific survival and reproduction rates and other demographic information, and the environmental variability in these parameters. The complexity of a PVA may range from a simple, deterministic model to a detailed, spatially-explicit, individual-based model that includes multiple populations. The degree of complexity for any particular PVA is likely to depend on the availability of data for a particular species, the management questions which need to be addressed, and the amount of time researchers can allocate to developing the PVA. PVAs have been developed for a number of species, including grizzly bears (Shaffer 1981, 1987), spotted owls (Lande 1988; Marcot and Holthausen 1987), desert tortoise (Doak *et al*. 1994), and loggerhead sea turtles (Crouse *et al*. 1987).

Use of PVAs became common in the last decade, particularly after the development of "canned" software programs which made PVA accessible to anyone with access to a computer. At this time, concerns about the potential mis-use of the approach began to arise. A number of authors discussed those concerns (e.g., Boyce 1992; Ralls and Taylor 1997; Beissinger and Westphal 1998). In general, there is broad support for the use of PVA as a process, which first requires the synthesis, evaluation, and integration of large amounts of data in order to determine what type of population model can be developed. In addition, support for the PVA approach increases when care is taken to generate a complex model and only when sufficient data are available for the species interest (e.g., Coulson *et al*. 2001). The initial PVA should be one step in a management/monitoring program designed to provide additional input for future PVA (e.g., Boyce 1992; Beissinger and Westphal 1998; Coulson *et al*. 2001).

The workshop recommended that a PVA approach be used to determine the risk of extinction for populations or DPSs of large cetaceans. Concerns were expressed that a

[6] A population's effective population size is defined (Meffe and Carroll. 1997) as the functional size of a population, in a genetic sense, based on numbers of actual breeding individuals and the distribution of offspring among families. The effective population size is typically smaller than the census size of the population.

PVA approach could result in scientific debate about the choice of models, model assumptions, or parameter estimates. Nevertheless, workshop participants generally agreed that PVA is the best available approach to determining the risk of extinction, makes the best use of available data, and provides a mechanism for identifying, evaluating, and prioritizing the significance of model assumptions and parameters uncertainties.

Workshop participants recognized that it may not be necessary to conduct a PVA for all species which may be reasonable candidates for recovery actions. For instance, if extinction is very unlikely purely based on the fact that a population has a very large estimated size, this could be the basis for a recommendation to deviate from the approach to recovery criteria outlined by workshop participants at this workshop.

A Bayesian approach to a PVA might be useful because both model inputs and outputs are probabilistic; however, workshop participants believed that the actual methods for conducting the PVA should be left up to the researchers doing the analyses as long as the methods were clearly specified and resulted in a defensible, reliable approach based on the best available data.

Criteria Must Explicitly Identify the Acceptable Risk and the Time Frame of Consideration

Two parameters need to be specified to provide a probabilistic risk assessment: the time frame of reference and the desired degree of certainty of continued existence (Shaffer 1981, 1987). The increasing levels of risk represented by threatened and endangered status require a decrease in the time scale or an increase in the probability of extinction, or both. The workshop concluded that it was not possible to specify these values because such specification is ultimately a policy decision rather than a biological one: society must choose the amount of "insurance" it wishes to maintain against the risk of the extinction of a species (Rohlf 1991). The scientific community can, however, provide guidance in selecting these values.

Some cautions regarding the time frame were provided by the review of PVAs conducted by Beissinger and Westphal (1998). Because any inaccuracies in demographic rates or environmental stochasticity propagate with each successive time step, Beissinger and Westphal (1998) suggested using relatively short time intervals, such as 10, 25, or 50 years, in conjunction with calculation of a conservative probability of extinction.

WORKSHOP RECOMMENDATION FOR LARGE WHALE RECOVERY CRITERIA

The ESA defines endangered species as those "in danger of extinction throughout all or a significant portion of their range". The guidance provided with respect to threatened species is that they are those which are “likely to become endangered within the foreseeable future.” The workshop noted that no consistent guidance has been provided for what should constitute “in danger of extinction”, “likely to become endangered”, or “within the foreseeable future”. Workshop participants generally agreed that it is highly desirable to develop quantitative thresholds for these terms, and also agreed that setting any thresholds would be at least partially subjective and would reflect a "societal comfort" with regard to an acceptable level of risk to a species.

Guidance available from the scientific literature is that the highest level of risk (probability of extinction, P_{EX}) that is acceptable by most conservation biologists and population geneticists ranges from a 20% chance in 10 generations to a 1%, 5%, 10%, and 50% chance in 100 years to a 1% chance of extinction in 1,000 years (Shaffer 1981, 1987; Soule 1987; Mace and Lande 1991; Thompson 1991). Authors addressing this matter typically did not justify why their choices of values represented the "highest acceptable risk". Instead, the reasoning generally reflected a judgement with regard to the author's willingness to accept a particular risk of extinction. Although there is not consensus in the literature regarding what the "highest acceptable risk" should be, the values provided in the literature demonstrate that the conservation biology community generally believes that the probability of extinction should be very small. Workshop participants generally agreed that a conservative estimate of the maximum acceptable risk would be anything $\geq$1 % chance of extinction in 100 years. If this is considered the maximum acceptable risk of extinction then it can be used to define the endangered criteria. *Thus, the workshop recommended that a reasonable, conservative trigger for "endangered" would be: the species is endangered if the probability of becoming extinct is greater than or equal to 1% in 100 years.*

The ESA defines threatened species as those which are likely to become endangered in the foreseeable future. This definition ties the criteria for threatened status to the criteria for endangered status. Thompson (1991) defined a threatened species as one which has a 50% chance of becoming "endangered" in 10 years. Thompson (1991) selected these values because he believed that 50% adequately reflected "likely"; no justification was provided for selecting 10 years. Mace and Lande (1991) followed a somewhat different approach in setting "vulnerable" under the IUCN classification scheme (roughly analogous to threatened) independently of endangered status. Using their approach and the values in the literature, acceptable risk values for threatened would be $0.01 \leq P_{EX} < 0.05$ in 100 years. As such, criteria for "threatened" can be defined by either associating the threatened criteria with the endangered criteria (e.g., 50% chance of reaching endangered status in 10 years; Thompson 1991) or by increasing the acceptable level of risk (e.g., $0.01 \leq P_{EX} < 0.05$ in 100 years). Participants also considered the applicability of the criteria used for Pacific salmon, that is regarding a species as threatened if the probability of becoming endangered was 50% in 10 years. Participants concluded that 50% in 10 years was not adequately conservative considering low reproductive rates for large whales and the fact that it may take more than 10 years to simply detect a significant trend in the size of a marine mammal population.

After considerable discussion, participants agreed that it would be most appropriate to adhere to the guidance of the ESA by linking the "threatened" status of a species to its likelihood of becoming "endangered". *The majority of workshop participants recommended that species be considered threatened if the probability of becoming endangered was greater than or equal to*

10% in 10-25 years; 20 years should be used as a general guideline.

Participants selected 20 years as a guideline for the time frame over which the probability of becoming endangered should be evaluated because it was a minimal length of time to carry out the following activities: determine population abundance, determine trends in abundance, determine what factors are negatively affecting the population, determine how to alleviate those factors, and implement management actions that will facilitate the recovery of the

Box 3: Case Study – Application of the proposed process to North Atlantic and North Pacific right whales

Section 4(a)(1) of the ESA explicitly requires that any determination of the status of a species consider the threats to a species from:

A) the present or threatened destruction, modification, or curtailment of its habitat or range;
B) overutilization for commercial, recreational, scientific, or educational purposes;
C) disease or predation;
D) the inadequacy of existing regulatory mechanisms; and
E) other natural or manmade factors affecting its continued existence.

The objective criterion to determine status will be a probability of extinction over a specified time period, as estimated using a robust method (such as Population Viability Analysis) that incorporates uncertainty and includes important risk factors, including (where relevant) the five factors noted above. This plan includes an assessment of the relevance of these five factors to right whale recovery.

A right whale DPS shall be considered endangered when, given current and projected conditions, the probability of extinction is greater than 1% in 100 years.

A right whale DPS shall be considered threatened when, given current and projected conditions, the probability of becoming endangered is greater than 10% in 20* years.

De-listing would occur when the RU no longer meets the criteria for endangered or threatened and all threats have been addressed. Therefore, de-listing would occur when the probability of becoming endangered within the next 20* years is equal to or less than 10%.

In the absence of suitably precise data for use in a PVA or similar model, surrogate measures may be substituted if they can be shown to give an equivalent probability of extinction or an equivalent probability of becoming endangered. Since population size and trend are important factors affecting the probability of extinction, the surrogate measures to consider should include these; however, they must be determined with adequate precision to ensure that the probability of extinction is less than 1% in 100 years.

Prior to any consideration of de-listing, a right whale RU will need to grow to substantially higher population levels and, where relevant, human-related mortality must be reduced to allow such population growth. Given the current small population sizes and low or negative rates of population growth, de-listing actions are not anticipated in the foreseeable future (e.g., decades or longer).

* Participants *noted* that the relevant time line for right whales would be 20 years. A longer time line was not recommended because substantial information has already been collected on right whale population size, trends in abundance, and sources of mortality. The profile of these species is sufficiently high that these types of data will likely be collected for the foreseeable future. Thus, it is unnecessary to add an additional level of conservatism by extending the time line.

population. However, workshop participants indicated that use of a 10-25 year time frame might be appropriate based on 1) the precision of the data on population abundance and trend information for a particular species, 2) the time it takes the agency to respond to a potential change in status, and 3) the time it will actually take the species to recover. For some species, such as those for which the cause(s) of decline are unknown, it is reasonable to use a longer time frame to ensure that there is an adequate buffer for research to document the extent and causes of the decline, and for management actions to take place.

Criteria for de-listing would then be that the species had a greater probability of persistence than that which would lead it to be listed as threatened (or endangered). That is, consider a listed species for de-listing if the probability of endangerment is < 10% in 20 years.

The workshop then applied this approach to North Atlantic right whales (Box 3) as a case study on the development of recovery criteria.

OTHER CONSIDERATIONS IN DEVELOPMENT OF THE CRITERIA

Surrogates/Defaults May be Necessary for Some Model Parameters

The workshop recognized that many data are needed to conduct a detailed PVA. For instance, detailed PVAs require estimates of the population size, density dependent, age-specific survival and reproduction rates, an assessment of the environmental variability in these parameters, and an estimate of the probability of a catastrophe that causes a severe reduction in survival. In addition, a detailed PVA requires information on the extent and impacts of inbreeding depression and the Allee effect. Modeling efforts must account for the factors reasonably expected to influence population trends over the time period modeled (i.e., 100 years), which will be very challenging but is essential for reliable estimation of the risk of extinction. Due to the difficulty of collecting detailed information on large cetaceans, much of this information will not be available for a PVA.

The workshop recommended that research be conducted to determine the following:

(1) Can default values be used for any of the parameters required for a PVA?
(2) Are there some parameters for which default parameters should never be used?
(3) Which default values should be case-specific (although not necessarily species-specific) and which default values can be used for all species?
(4) Should a quasi-extinction level be used as a “cushion” to provide an additional level of conservatism?

There is precedence for the use of default values in management models for marine mammals. Under the MMPA, an index called the Potential Biological Removal level (PBR) is calculated and used as a trigger for management actions. Although species-specific data are always required for the calculation, some default values may be used if species-specific parameters are not available. Default values can, and should, be selected carefully to ensure that they are reasonable for the group of species being addressed. In particular, default values must be consistent with observed trends (e.g., default values for survival and reproductive

rates that lead to positive growth rates cannot be used for a population exhibiting negative growth.)
Workshop participants recognized that there would be insufficient time during the workshop to develop standards or default values for use in a PVA. Instead, participants recommended that NMFS commit to developing a process to determine 1) which variables we need for a PVA, 2) which variables can be replaced by default values, 3) the appropriate default values, and 4) standards for PVA, if necessary. It was suggested that a meeting be convened to address this, and that providing support to a graduate student or post-doctoral associate might be an excellent and cost-effective way to do the modeling necessary to ensure that any recommended default values were appropriately conservative.

All Five Statutory Factors Are Subsumed in the Recovery Criteria, but Must Be Addressed in the Recovery Plan

The workshop acknowledged the statutory requirement that the five areas of potential threats, or the five factors, identified in the ESA must still be addressed in recovery plan criteria for de-listing a species. That is, it must be clear that negative impacts resulting from the five factors can no longer have a significant effect on the population for it to meet the recommended recovery criteria and to be considered for a change in listing status. The recovery criteria and the PVA must consider all five factors, though it is to be expected that in any given PVA not all of these factors will necessarily prove to be important from a population (versus a legal or statutory) perspective. Thus, it may not be necessary to explicitly develop objective, measurable criteria for each of the five factors, though it is reasonable to expect that all of the factors should be incorporated into the recovery criteria, and considered during the development of the PVA. In addition, since the biology, range, habitat needs, and management concerns will be different for each species, addressing the five factors will require a species-specific approach. If a factor cannot be addressed in the PVA exercise, then the power or realism of the PVA should be questioned, and decision-makers must be made aware of the relative rigor of the PVA models used.

As a case in point, during the development of recovery criteria for salmonids, the Northwest Fisheries Science Center advised the Northwest Regional Office/NMFS (NWR) about relative extinction risk, and allowed the NWR to address the five factors. This approach was possible because it separated technical assessments about population status (i.e., risk of extinction) from assessments of the impacts of original causes of the populations' decline.

Transboundary Issues

Throughout the workshop, participants cited concerns about how transboundary species or populations (i.e., those having ranges that included waters of two or more countries) would be addressed when recovery criteria are implemented. For example, if "re-colonization of historical areas" is required when addressing the five factors, it is not clear that re-colonization of historical areas that occur outside U.S. waters is required by the ESA. In addition, the lack of appropriate conservation measures in international waters and in the territorial waters of some nations may preclude de- or down-listing populations in those areas, even if the portion of the population which occurs in U.S. waters could be considered a candidate for recovery actions. There was general agreement that scientists and managers would have to carefully consider the ramifications of any recovery actions of any transboundary population prior to taking action.

Asymmetrical Up-Listing/Down-Listing Criteria

Some workshop participants indicated that it might be appropriate to establish de-listing criteria that are more conservative or precautionary than listing criteria. For example, listing might be based on a 20% (or more) probability of becoming endangered in 20 years, and de-listing might be based on a 10% (or less) probability of becoming endangered in 20 years. Although no specific recommendation regarding this issue was made, there was general agreement that asymmetrical up- and down-listing criteria might be appropriate.

Alternative Approaches Considered in Formulating the Criteria

The group considered additional approaches to developing recovery criteria. While the justifications for using these criteria were useful bases for the discussion, the workshop concluded, for the reasons identified here, that they were not applicable models for the task at hand.

(1) <u>The IUCN approach</u> - Criteria developed by the IUCN are useful, but are difficult to apply to highly migratory species. In addition, because the criteria were intended for application to species at a global level, these criteria were viewed as not being sufficiently regionally specific.

(2) <u>Recovery criteria based solely on the five factors without explicit consideration of the probability of extinction</u> - The workshop participants concluded that this approach was inadequate because factors other than human-related activities could be involved. For example, cases could arise where there is a 75% reduction in human-related mortality, but there is still a very small population that would be very susceptible to extinction. Species in this or similar situations should not be considered candidates for de-listing.

(3) <u>Recovery criteria based solely on trends in abundance (e.g., reduce human induced mortality until there is a 95% chance that the population is increasing)</u> - If this approach were adopted, it would be necessary to measure the reduction in human induced mortality and the trend in population size with great accuracy, both of which could be quite challenging. In addition, cases could arise where these criteria could be met but the population could still be very small and very susceptible to extinction.

(4) <u>Recovery criteria expressed in terms of the probability of extinction (e.g., the criteria for endangered would be "xx% chance of extinction in yy years" and the criteria for threatened would be "zz% chance of extinction in qq years", where qq would be</u>

greater than yy) - The workshop endorsed this approach to defining recovery criteria from endangered to threatened, but the workshop considered this approach to be inappropriate for de-listing species from the ESA because it is not consistent with the language for the definition of threatened as reflecting the risk of becoming endangered.

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APPENDIX I

WORKSHOP AGENDA

<u>**26 February**</u>

8:30 Welcome, terms of reference, expected products

Legislative and regulatory history of listing/delisting/downlisting criteria

8:45 ESA requirements [Johnson]

9:00 NMFS perspective on de-listing, down-listing, and “recovery criteria” [NMFS lawyer and Johnson]

9:20 FWS perspective on ESA criteria [FWS lawyer and Johnson]

9:40 IUCN approaches to criteria [Taylor]

10:00 Break

Developing criteria for marine species

10:15 Review of the history of marine mammal ESA de-listing criteria in recovery plans (gray and other whales, monk seals, manatees, sea otters, Stellers) [DeMaster]

10:45 ESA listing/de-listing criteria for salmon

11:00 CITES WG discussions on criteria for marine species [Smith]

11:15 Obstacles to developing criteria for large whales [DeMaster]

11:45 Review of mornings discussions and presentations

12:00 Lunch

Approaches to moving forward on large whale criteria

1:00 Possible approaches [Wade/DeMaster]

2:00 Discussion of a general 3-5 element framework that can be applied to all endangered large whale species [Group]

3:15 Break

3:30 What should the general framework be? [Group]

5:15 Review of day's discussion; order of business for the next

5:30 Adjourn

Evening - potential meeting of subgroups

<u>27 February</u>

Applying the general framework to individual species

8:30 Available data and issues for key species (20 min each)
- Right whales [Clapham/Brownell]
- North Atlantic humpbacks [Smith]
- North Pacific humpbacks/blue whales [Barlow]

9:30 Break-out groups meet separately to discuss draft "criteria" to flesh out the general frameworks for :
- Right whales
- Humpback whales
- Blue whales

12:00 Lunch

1:00 Subgroup reports and synthesis of discussions

2:00 Focused discussion of "specific criteria" for right whales.

4:30 Summary; next steps

5:00 Adjourn

APPENDIX II
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APPENDIX III

BACKGROUND MATERIALS

1. Pages 5-6 of the Endangered Species Act

2. Easter-Pilcher, A. 1996. Implementing the Endangered Species Act. 1996. BioScience. 46(5): 355-363.

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10. Stock Assessment Reports

APPENDIX IV

IUCN Criteria for Critically Endangered, Endangered, and Vulnerable

As approved by the 40th Meeting of th IUCN Council, Glans, Switzerland, 30 November 1994

CRITICALLY ENDANGERED (CR)

A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by any of the following criteria (A to E):

A) Population reduction in the form of either of the following:

1) An observed, estimated, inferred or suspected reduction of at least 80% over the last 10 years or three generations, whichever is the longer, based on (and specifying) any of the following:

a) direct observation
b) an index of abundance appropriate for the taxon
c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
d) actual or potential levels of exploitation
e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2) A reduction of at least 80%, projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying) any of (b), (c), (d) or (e) above.

B) Extent of occurrence estimated to be less than 100 km2 or area of occupancy estimated to be less than 10 km2, and estimates indicating any two of the following:

1) Severely fragmented or known to exist at only a single location.

2) Continuing decline, observed, inferred or projected, in any of the following:
a) extent of occurrence
b) area of occupancy
c) area, extent and/or quality of habitat
d) number of locations or subpopulations
e) number of mature individuals.

3) Extreme fluctuations in any of the following:
a) extent of occurrence
b) area of occupancy
c) number of locations or subpopulations
d) number of mature individuals.

C) Population estimated to number less than 250 mature individuals and either:

1) An estimated continuing decline of at least 25% within 3 years or one generation, whichever is longer or

2) A continuing decline, observed, projected, or inferred, in numbers of mature individuals and population structure in the form of either:

a) severely fragmented (i.e., no subpopulation estimated to contain more than 50 mature individuals)
b) all individuals are in a single subpopulation.
D) Population estimated to number less than 50 mature individuals.
E) Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or 3 generations, whichever is the longer.

ENDANGERED (EN)
A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by any of the following criteria (A to E):
A) Population reduction in the form of either of the following:
1) An observed, estimated, inferred or suspected reduction of at least 70% over the last 10 years or three generations, whichever is the longer, based on (and specifying) any of the following:
a) direct observation
b) an index of abundance appropriate for the taxon
c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
d) actual or potential levels of exploitation
e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.
2) A reduction of at least 50%, projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying) any of (b), (c), (d), or (e) above.
B) Extent of occurrence estimated to be less than 5000 km2 or area of occupancy estimated to be less than 500 km2, and estimates indicating any two of the following:
1) Severely fragmented or known to exist at no more than five locations.
2) Continuing decline, inferred, observed or projected, in any of the following:
a) extent of occurrence
b) area of occupancy
c) area, extent and/or quality of habitat
d) number of locations or subpopulations
e) number of mature individuals.

3) Extreme fluctuations in any of the following:
a) extent of occurrence
b) area of occupancy
c) number of locations or subpopulations
d) number of mature individuals.
C) Population estimated to number less than 2500 mature individuals and either:
1) An estimated continuing decline of at least 20% within 5 years or 2 generations, whichever is longer, or
2) A continuing decline, observed, projected, or inferred, in numbers of mature individuals and population structure in the form of either:

a) severely fragmented (i.e., no subpopulation estimated to contain more than 250 mature individuals)
b) all individuals are in a single subpopulation.

D) Population estimated to number less than 250 mature individuals.

E) Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or 5 generations, whichever is the longer.

VULNERABLE (VU)

A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by any of the following criteria (A to E):

A) Population reduction in the form of either of the following:

1) An observed, estimated, inferred or suspected reduction of at least 20% over the last 10 years or three generations, whichever is the longer,, based on (and specifying) any of the following:
a) direct observation
b) an index of abundance appropriate for the taxon
c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
d) actual or potential levels of exploitation
e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2) A reduction of at least 20%, projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying) any of (b), (c), (d) or (e) above.

B) Extent of occurrence estimated to be less than 20,000 km2 or area of occupancy estimated to be less than 2000 km2, and estimates indicating any two of the following:

1) Severely fragmented or known to exist at no more than ten locations.

2) Continuing decline, inferred, observed or projected, in any of the following:
a) extent of occurrence
b) area of occupancy
c) area, extent and/or quality of habitat
d) number of locations or subpopulations
e) number of mature individuals.

3) Extreme fluctuations in any of the following:
a) extent of occurrence
b) area of occupancy
c) number of locations or subpopulations
d) number of mature individuals.

C) Population estimated to number less than 10,000 mature individuals and either:

1) An estimated continuing decline of at least 10% within 10 years or 3 generations, whichever is longer, or

2) A continuing decline, observed, projected, or inferred, in numbers of mature individuals and population structure in the form of either:

a) severely fragmented (i.e., no subpopulation estimated to contain more than 1000 mature individuals)
b) all individuals are in a single subpopulation.

D) Population very small or restricted in the form of either of the following:
1) Population estimated to number less than 1000 mature individuals.
2) Population is characterised by an acute restriction in its area of occupancy (typically less than 100 km2) or in the number of locations (typically less than 5). Such a taxon would thus be prone to the effects of human activities (or stochastic events whose impact is increased by human activities) within a very short period of time in an unforeseeable future, and is thus capable of becoming Critically Endangered or even Extinct in a very short period.

E) Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

LOWER RISK (LR)

A taxon is Lower Risk when it has been evaluated, but does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories:

1. Conservation Dependent (cd). Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation programme targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.
2. Near Threatened (nt). Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable.
3. Least Concern (lc). Taxa which do not qualify for Conservation Dependent or Near Threatened.

DATA DEFICIENT (DD)

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat or Lower Risk. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and threatened status. If the range of a taxon is suspected to be relatively circumscribed, if a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED (NE)

A taxon is Not Evaluated when it is has not yet been assessed against the criteria.