Review of the 2007 Draft Steller Sea Lion Recovery Plan

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For

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Executive Summary

The Steller sea lion (*Eumetopias jubatus)* was listed under the Endangered Species Act (ESA) as a threatened species throughout its range in 1990. The National Marine Fisheries Service (NMFS) appointed a recovery team, and in 1992 they approved a Recovery Plan based on a draft prepared by the team. In 1997 the species was split into two Distinct Population Segments (DPS), and the eastern DPS was left classified as threatened under the ESA while the western DPS was uplisted to endangered. In 2001, NMFS assembled a new recovery team to assist them with revising the initial Plan. The team provided its draft of the revised plan to NMFS in March 2006. After releasing the first draft for public review and evaluating the comments received, NMFS decided to prepare a revision.

The revised draft Recovery Plan released for review in May 2007 incorporates new information on Steller sea lions (SSL), their habitat, threats that may be affecting the dynamics of each DPS, and actions needed to promote recovery. Because of the importance of this revised Plan as guidance for future management of SSL in Alaska, the North Pacific Fishery Management Council asked the North Pacific Research Board to convene a panel of three independent scientists to review and comment on seven questions prepared by the Council. This is the report of that review panel.

Question 1. Does the Plan thoroughly describe what is known about potential threats to both the eastern and western populations of SSL? Are there additional significant threats to the species? Does the evidence presented in the Plan support the threats assessment? Are the threats as described in the Plan compelling threats to the reviewer; does the evidence fully support listing all of these as threats?

Review Panel Response

- The draft Plan provides a thorough description of the potential threats that might be operating on the both the eastern and western DPS. The review panel is not aware of any scientific literature or reports relevant to threats that have not been summarized, discussed, and cited.
- The draft Plan concludes that only two threats are potentially of high impact to the western DPS, competition with fisheries and environmental variability. The review panel agrees with this conclusion.
- The review panel believes that the following factors identified in the Plan as medium or low threats to the western DPS should be changed to “not currently a threat to recovery”— toxic substances; illegal shooting; entanglement in marine debris; disturbance from vessel traffic and tourism; and disturbance from research.

Question 2. Is the ecological and biological information presented in the Plan adequate, thorough, and scientifically defensible?

Review Panel Response

- Overall, the review panel believes that the draft Plan presents an up-to-date and balanced review of what is known of the ecology and biology of the SSL. The literature cited is comprehensive and the best available scientific evidence has been used in the Plan.

- The overall increase in non-pup numbers in the western DPS during 2000-2004 was not evenly spread across the population, underscoring the complex dynamics of SSL and that presumably multiple factors are acting on the western DPS.
- There have been considerable advances in our understanding of SSL diets, and the movements and foraging behavior of juveniles. However, it is likely that we lack a complete understanding of the variability in adult female movements and foraging behavior. This remains an important gap in knowledge. Movements and foraging behavior of adult males have not been studied.
- Changes in the vital rates of SSL over space and time are clearly and concisely presented in the draft Plan. Despite the estimated increase in juvenile and adult survival, evidence for continued low birth rates through 2004 in the central Gulf of Alaska suggests that many females are still unable to obtain adequate nutrition to successfully support pregnancy. The balance of evidence does not support the junk-food hypothesis as the mechanism leading to chronic nutritional stress in the western SSL DPS.

Question 3. Does the Plan adequately present an ecologically and biologically defensible recovery strategy for the western population of SSL? Describe any shortcomings in the recovery strategy. Are there other interpretations of the ecological and biological information, and the recovery strategy derived from these interpretations, that might hold equal merit to the interpretations presented in the plan?

Review Panel Response

- Overall, the panel believes the draft Plan presents a reasonable approach to the recovery strategy. However, the review panel has two observations. First, although adaptive management might provide benefits to SSL, we are concerned that there has been little progress toward designing a feasible approach or to specifying the research/management actions that will be needed. Second, we note that the implementation plan action item described in the draft Plan calls for the development of a multiple-hypothesis modeling approach to simultaneously examine the strength of evidence for multiple threats. Given both the empirical and modeling-based evidence that multiple threats have had a complex spatial-temporal effect on SSL dynamics, we endorse this approach in moving forward with actions to recover SSL.
- Although the weight of evidence approach to developing recovery criteria is necessarily somewhat subjective, the panel feels that the recovery criteria used in the plan are reasonable as they capture the need for sustained evidence of population increase and that this increase be widely distributed throughout the population.

Question 4. Are the recovery actions described within the Plan appropriate to meet recovery goals? Are the recovery actions consistent with the SSL life history information, population dynamics, and threats assessment presented in the Plan? Are there other recovery actions that have not been included in the Plan that should be included to achieve recovery? Is there sufficient evidence in the scientific literature, as presented in the plan, to suggest that the recommended recovery actions will work?

Review Panel Response

- In general, the review panel believes that the recovery actions presented in the Plan should promote the recovery of the western SSL DPS. The panel believes that the recovery actions are consistent with current knowledge of SSL ecology and population

dynamics and the threats facing this segment of the population. However, as the factors limiting recovery are presently poorly understood, the panel cannot be certain that there are not other actions that might be appropriate.

- The review panel agrees that continued population monitoring should be considered a high priority recovery action. Priority should also be given to continued efforts to estimate survival, natality, and dispersal to understand population responses to natural environmental variability, human influences, and recovery actions.
- The review panel agrees with the need to develop an implementation plan guided by the principles of multiple causation affecting population dynamics and long-term consistent monitoring.
- The threats assessment has concluded that the only high threats to recovery of SSL result from nutritional limitations, so action item 2.6 is therefore a crucial part of the draft Plan. Since the only factor affecting the SSL prey base that is subject to management is commercial fishing, the central question is how can commercial fisheries be managed to ensure that their actions do not limit SSL reproduction and survival?
- There are essentially two ways in which managers can proceed to answer this question. The first is an observational/descriptive approach in which an attempt is made to gather detailed information on SSL diet, prey species, and how fishing practices can be manipulated to ensure that SSL can acquire an appropriate diet. The review team believes, however, that even given the extraordinary amount of funding that has been made available for SSL recovery in recent years and the resulting advances in knowledge, such an approach is unlikely to yield a conclusive and comprehensive understanding of how to manage commercial fisheries so as to minimize their impacts on SSL.
- The alternate approach is to use field experiments and adaptive management to assess how SSL respond to various levels and types of fishing on species that comprise their prey base, as described in actions 2.6.4 and 2.6.8. While recognizing the numerous difficulties involved in such an endeavor, the review team endorses that approach.
- The review team agrees that it is essential that all fisheries that might impact the prey base of SSL, including those managed by the State of Alaska, be evaluated and managed in a manner such that they will have negligible impacts on population recovery.

Question 5. Are the recovery tasks in the Plan's Implementation Schedule appropriately prioritized to facilitate recovery?

Review Panel Response

- Overall, the review panel believes that the priorities assigned in the Plan to the various recovery actions are appropriate to facilitate recovery of the western SSL DPS. However, the panel's priorities differ from the draft Plan on some specific actions as discussed below.
- Although the review panel agrees that continued monitoring of pups and non-pups is among the highest priorities, we believe that it is equally important to obtain a better understanding of changes in the vital rates (action 1.2.1) that are responsible for the spatial and temporal changes in abundance and to incorporate these new data into a modeling framework that will help guide future research and management actions. Such a modeling framework is alluded to in actions 1.5 and 2.4.3, but it should be given more prominence in the draft Plan and assigned priority 1.

- Given the over-riding importance of having an implementation plan to provide specific guidance for recovery actions, the panel believes that action 1.5 should be given priority 1 in the draft Plan.
- There are several recovery actions that relate to assessing the impact of fisheries or fisheries management regulations on SSL habitat and food availability (actions 2.6.4, 2.6.6, 2.6.7 and 2.6.8), each of which is given primary priority 2a. Although, the panel agrees with this assessment, we also recommend that they be dealt with in an integrated manner and not as separate actions.
- The panel believes there is merit in gaining a better understanding of the impact of killer whale predation on the current and future dynamics of SSL and that the priority given to actions 4.3.2, 4.3.4, and 4.3.6 are appropriate. However, the panel believes the implementation plan will have to carefully balance the priority given to this research, especially if funds are insufficient to address other recovery actions that may have a more direct effect on recovery.
- As discussed under question 1, there are five potential threats to the western DPS identified in the draft Plan that the review team believes should be considered as not currently a threat to recovery. As such, we believe that action items relating to those topics should all be given priority 3.

Question 6. Does the information in the Plan appropriately support the recovery criteria described in the Plan? Are the recovery criteria consistent with and do they meet the requirement of the Endangered Species Act (ESA) to ensure the conservation of the species (i.e., recovery and ultimate delisting: "conservation" as defined in the ESA [16 USC Section 1532(3)]).

Review Panel Response

- The review panel believes that the best available information was used to develop recovery criteria, that the information contained in the revised plan reasonably supports the recovery criteria, and that the recovery criteria are consistent with and appear to meet the requirements of the ESA. The rationale provided in the Plan for using the weight of evidence approach to develop recovery criteria, informed by the PVA commissioned by the team, makes sense at this time.

Question 7. Does the Plan fairly weigh competing hypotheses on the causes of the decline, and/or lack of recovery, of the western population of SSL?

Review Panel Response

- The review panel believes the draft Plan has reasonably considered the evidence and the arguments for and against both major groups of hypotheses: food limitation and direct mortality. The preponderance of evidence fails to support two popular hypotheses – the junk food hypothesis for food limitation and the sequential megafaunal collapse for direct mortality.
- The draft Plan covers the potential of fisheries competition fairly, noting the circumstantial evidence in favor of an impact, but also noting the need for additional research, including direct experimentation, to understand unambiguously the impact of fisheries on SSL.

Summary Comments

The reasons for the dramatic decline of the western DPS of SSL may never be known with any certainty. Clearly, some conservation measures (e.g., protection from killing) have had positive impacts on the dynamics of SSL, but the benefit of others (e.g., critical habitat and fishery conservation measures) remains uncertain. Nevertheless, the recent increase in numbers in this segment of the population is a welcome development. This increase has not been observed uniformly across the western portion of the U.S. population underscoring the need to recognize that limiting factors must differ either in nature or magnitude throughout the range. The panel believes that this fundamental realization is captured in the draft Plan and that the application of recovery actions and their evaluation within this context should provide the best opportunity to both understand and ameliorate the threats limiting the recovery of the western DPS of SSL.

BACKGROUND

The Steller sea lion (*Eumetopias jubatus)* was listed as a threatened species under the Endangered Species Act (ESA) on April 5, 1990 due mostly to substantial declines in abundance in the western portion of its range. The first Recovery Plan, which covered the entire range of the species, was drafted by a recovery team and approved by the National Marine Fisheries Service (NMFS) in December 1992. However, the first Plan became obsolete after the species was classified into two Distinct Population Segments (DPS) in 1997, with the eastern DPS remaining listed as threatened and the western DPS uplisted to endangered. Furthermore, nearly all of the recovery actions contained in the first Plan had been completed. Therefore, in 2001 NMFS assembled a new recovery team to assist them with producing a revised Plan.

The revised draft Recovery Plan incorporates new information on Steller sea lions (SSL), their habitat, threats that may be affecting the dynamics of the western DPS and actions to promote recovery. NMFS received a first draft of the Plan from the recovery team in March 2006, and released it for public review in May 2006. The North Pacific Fishery Management Council and its Scientific and Statistical Committee reviewed that draft of the Plan, as did members of the public. NMFS has received those comments, some of which suggested extensive revisions to the Plan. Based on the Scientific and Statistical Committee comments, comments received from the public, and its own review, and because of the importance of this Plan as a guidance document for future management of SSL in Alaska, the Council asked NMFS to prepare a revised draft of the Plan. In May 2007, NMFS released a second draft of the Plan.

The North Pacific Fishery Management Council asked the North Pacific Research Board to convene a panel of three independent scientists to review and comment on seven questions, prepared by the Council, pertinent to the Draft Revised SSL Recovery Plan, May 2007 (hereafter referred to as "the Plan"). Those seven questions (listed below under Analysis and Review) comprise the Statement of Work. This is the report of that review panel.

REVIEW AND ANALYSIS

Question 1

Does the Plan thoroughly describe what is known about potential threats to both the eastern and western populations of SSL? Are there additional significant threats to the species? Does the evidence presented in the Plan support the threats assessment? Are the threats as described in the Plan compelling threats to the reviewer; does the evidence fully support listing all of these as threats?

Review Panel Response

The draft Plan provides a thorough description of the potential threats that might be operating on both the eastern and western DPS. The review panel is not aware of any scientific literature or reports relevant to threats that have not been summarized, discussed, and cited. Documents cited include papers published in journals through 2007, as well as others in preparation and in review, and unpublished data.

The list of threats used to organize this section is very similar to that used for evaluating likely causes of the decline of SSL in the first Recovery Plan, as well as for evaluating threats in recovery/conservation plans for North Pacific fur seals, Cook Inlet beluga whales, and southwest Alaska sea otters. If there are significant additional threats that might be affecting SSL, they are not apparent to the review panel.

For the western DPS, the draft Plan devotes about 40 pages to describing threats and assessing their possible impact on population recovery. It defines a threat as "any factor (natural or human related), which represents a substantial impediment to recovery." The threats assessment uses a "weight of evidence" approach to rank the overall potential impact of each threat, "using the extensive expertise of the recovery team." The review panel agrees that the recovery team included members with substantial knowledge of the biology and ecology of SSL, the characteristics of their ecosystems, and the types of natural and human-related threats that might impact population recovery. The conclusions resulting from the assessment are summarized in Table 1, below. The plan concludes that only two threats are potentially of high impact, competition with fisheries and environmental variability. The review panel agrees with this conclusion. However, we believe that each of these should be listed as "high" rather than "potentially high" as the concept of potential is inherent in something being a threat.

The remaining nine threats are ranked as medium or low. The review panel believes that available data allow a somewhat more rigorous evaluation of some of these "second tier" threats. In several cases items are on the list not because there is positive information indicating a negative impact on the population, but rather because a lack of information does not allow the possibility of impact to be ruled out. In such circumstances, the prudent and precautionary approach would be to leave items on the list of potential threats. However, in the SSL situation there are two DPSs showing opposite population trajectories, and evaluation of how each threat applies to each segment could help evaluate which are likely to be operative in the current situation (see Table 1). In other words, if a threat is operating similarly in both DPSs, since the eastern DPS has been increasing over the long term it is unlikely that that threat is seriously impacting the western DPS unless there is some other factor involved. Using that logic, the review team believes that the following factors identified as medium or low threats to the western DPS should be changed to "not currently a threat to recovery"—toxic substances; illegal shooting; entanglement in marine debris; disturbance from vessel traffic and tourism; and disturbance from research. The remaining threat factors—killer whales; incidental take by fisheries; Alaska Native subsistence harvest; and disease and parasitism—should remain listed as threats as currently done in the draft Plan.

For the eastern DPS, the threats assessment in the draft Plan is less formal, and the conclusions more implied than clearly stated. The categories of threats assessed are generally similar, but not identical, to those used for the western segment, and the apparent conclusions are shown in Table 1. The document specifies for several threats that "there is no evidence to support that any either individually or collectively are current threats to recovery," but for several others there is no stated conclusion. Nevertheless, the overall logic of this analysis, that since the eastern DPS has increased by 3%/year for the past 25-30 years there are no threats seriously impeding recovery, should not be disputed.

Table 1. Summary of conclusions regarding importance of threats for the western and eastern SSL DPSs. Items shown in brackets under the western DPS are those that the review team believes should be changed to "not currently a threat to recovery." Note that the terms used to describe the threat are those used in the draft Recovery Plan for the western DPS, and the categories used for the eastern DPS were similar, but not identical.

Threat listed in draft recovery plan	**Relative impact to recovery based on recovery plan threats assessment**	
	Western DPS	**Eastern DPS**
Environmental variability	Potentially high	Not specified
Competition with fisheries	Potentially high	Not specified
Killer whales	Medium	Not currently a threat to recovery
Toxic substances	[Medium]	Not currently a threat to recovery
Incidental take by fisheries	Low	Not currently a threat to recovery
AK Native subsistence harvest	Low	Not specified
Illegal shooting	[Low]	Not specified
Entanglement in marine debris	[Low]	Not specified
Disease and parasitism	Low	Not specified
Disturbance from vessel traffic/tourism	[Low]	Not currently a threat to recovery
Disturbance from research	Low	Not currently a threat to recovery

Question 2

Is the ecological and biological information presented in the Plan adequate, thorough, and scientifically defensible?

Review Panel Response

The review panel feels that the draft Plan presents an up-to-date and balanced review of what is known of the ecology and biology of SSL. We note, however, that some references are missing from the bibliography (e.g., Harlin-Cognato et al. 2006; Hoffman et al. 2006; Frid et al. 2006) and others were not readily available to the review panel (e.g., Gelatt et al. 2006; Rehberg 2005; Calkins et al. 2005) and therefore could not be evaluated. Nevertheless, the literature cited is comprehensive and the panel believes that the best available scientific evidence has been used in the Plan.

Distribution and Population Structure

Research on the stock structure of SLL has been an important contribution to our understanding of the ecology of this species. The designation of two DPSs is well supported by both resightings of individually marked individuals and extensive genetic research. The finding that genetic diversity is high despite the dramatic decrease in population numbers suggests that there should

be no genetic impediment that would prevent population recovery. Since the original designation of the western and eastern DPSs, additional genetic research has generally confirmed the strong east-west population structure, but has also shown that there is less distinction when both males and females are included in the analysis. One explanation for this finding is a greater level of male-mediated gene flow than of female gene flow because males tend to disperse further than females. Another important recent finding is that a large fraction of the pups in newly established rookeries in the eastern DPS were born to western DPS females. As noted in the draft Plan, the movements of females between DPSs (thus far only west to east) and the large dispersal distance of sea lions from their natal rookeries have important implications for re-colonization and expansion of the depleted western DPS. Given these findings, continued genetic research is likely to pay further dividends.

Population Status

The draft Plan provides a concise and up-to-date review of the methods used to estimate SSL abundance and trends since the late 1950s and does a good job of reviewing the differing rates of population change over time and across the geographic distribution of the species. The Plan also highlights the overall increase in non-pup numbers in the western DPS during 2000-2004 and notes that these changes were not evenly spread across the population, again underscoring the complex dynamics of SSL and that presumably multiple factors are acting on the western population. However, the recent overall rate of increase for the western DPS is far less than might be expected for a pinniped population that is well below carrying capacity. Although more surveys will be needed to estimate better the pattern of recent trends in abundance, these changes are critically important both in terms of eventually providing further insight as to the underlying causes of population change and assessing the effects of previously instituted and proposed management measures on the dynamics of the western DPS.

Over the past several decades, the eastern DPS of SSL has increased at a rate of about 3% per year. Again, based on what we know about other pinnipeds this rate of increase is lower than what would be expected from a population well below carrying capacity, but it is the only measured, long-term rate of increase available for SSL.

Habitat Characteristics and Use

The description of the terrestrial and marine habitats used by SSL, although accurate, is rather brief with little discussion of key components of marine habitats, such as prey characteristics or diving behavior, the third dimension of foraging. There is little integration of the information on movement patterns and diving that could provide a better understanding of areas and depths frequently used. This is partly because some of the relevant issues are covered in the section on foraging ecology and elsewhere. However, greater reference to age and seasonal differences in diving and movement and availability of prey and distribution of predators would have resulted in more valuable characterization of marine habitat.

Table 1-12 provides a concise description of the numbers and characteristics of the SSL that have been equipped with radio and satellite-linked tags. The review panel acknowledges the tremendous effort and expertise needed to conduct those studies. However, the text would have benefited from a summary paragraph discussing the extent to which current data can be considered representative of the whole population. As recommended by a number of previous workshops and review panels, most of the effort has been to describe the movements and

foraging patterns of juveniles. Relatively few adult females (14 in summer and 10 in winter) have been tagged in the Aleutian Islands and Gulf of Alaska and many of those satellite tracks cover relatively short periods. Another 8 females have been tracked from the Kuril Islands, Russia. Given the broad geographic distribution of SSL and the regional differences in prey assemblages, it seems highly probable that we lack a complete understanding of the variability in adult female movements and foraging behavior. The review team regards this as a critical gap in knowledge. Finally, although adult males have not been tagged for a number of good reasons, given their larger size it is likely that they use marine habitats in ways that are different than adult females or juveniles. Thus, we should not lose sight of the fact that habitat use by the adult male component of the population is poorly understood.

Vital Rates

Changes in the vital rates of SSL over space and time are clearly and concisely presented in the draft Plan. Since the seminal work by York (1994), there have been a number of studies that have estimated trends in birth and survival rates. Although most of those studies necessarily have used many of the same data to fit population models, a relatively consistent pattern of spatial-temporal changes in juvenile and adult survival has emerged. The spatial-temporal pattern in estimated birth rates has been less consistent, but all studies have found that birth rates in the central Gulf of Alaska declined during the 1980s. Perhaps more importantly and despite the estimated increase in adult survival, Holmes et al. (under review) provide convincing evidence for continued low birth rates (inferred from fraction of juveniles in the population) through 2004 in the central Gulf of Alaska, the only area for which there are data to fit a pre-decline age-structure model. Given the evidence linking female condition to birth rates both in SSL and in a number of other mammals, this suggests that, despite better survival, many females are unable to obtain adequate nutrition to successfully support pregnancy.

Despite recent evidence for positive trends in abundance throughout much of the western DPS, SSL have experienced a dramatic decline in numbers since the 1970s and thus there is a need to forecast the risk of extinction. Population viability analysis (PVA) is a tool that attempts to predict the probability of a population going extinct over a specified period of time. There have been four PVA studies of the western DPS of SSL, including one commissioned by NMFS to assist in developing the revised Plan. Again, these studies necessarily have used many of the same data, but the models make quite different assumptions and handle uncertainty in somewhat different ways. The draft Plan does a good job summarizing the results of these PVAs and the effects of differing assumptions on predicted times to extinction or to some specified population threshold level.

Feeding Ecology

Given that the two major threats to SSL are related to their nutrition a thorough understanding of SSL feeding ecology and those factors affecting it is critical. Considerable new information has become available in the past five years and is represented in the draft Plan. The Plan has thoroughly reviewed the information available on SSL diets, which spans the past 3-4 decades. The data are primarily from stomach samples in the earlier decades and from scat samples since 1990. Studies after the 1970s are more substantive than the earlier studies, and since 1990 samples have been collected more systematically and therefore provide a greater capability for examining seasonal and spatial patterns. These studies indicate that SSL are generalist predators eating a large number of both fish and cephalopod species. Although the draft Plan notes an

apparent change in the predominant species in SSL diets based on stomach contents from the 1970s to the 1980s, it is rightfully cautious about making too much of this apparent difference when trying to draw conclusions about changes in diet prior to the mid-1970s and subsequently (the period associated with a climate regime shift). Fritz and Hinckley (2005) argue persuasively of the limitations of this comparison. They note that the earlier data were based on only seven studies in the western DPS, which generally had small samples sizes (some as few as three or four samples) and were taken from different locations and different seasons. It is clear from recent studies, such as Sinclair and Zeppelin (2002), based on almost 4,000 scats collected between 1990 and 1998, that season and location are important components of variability in SSL diets.

The primary means of obtaining both spatial and temporal information on foraging activity of SSL is through data loggers, such as time-depth recorders and satellite-linked telemetry tags. Telemetry studies of SSL foraging behavior began in the 1990s and the draft Plan has comprehensively reviewed and summarized what has been done. Although much research has been done and the data have been useful in establishing conservation actions, the work still represents a fraction of the information needed. The earliest work focused on adult females, but resulted in small sample sizes. Based on demographic modeling, which indicated reduced juvenile survival, subsequent work focused on juveniles and young of the year. These studies were generally better designed with larger sample sizes and a broader geographic distribution of tagging effort. One of the limitations of some of the juvenile data is that some of the instrumented juveniles were not weaned, whereas others were. As the movements of dependent SSL presumably mainly reflect the behavior of their mothers, this adds an extraneous variable that potentially reduces the power to detect behavioral differences among age classes. The draft Plan acknowledges the need to enhance the understanding of the feeding ecology of adult females, given the model estimates of continued reduced birth rates in the western DPS.

Nutritional Stress

Nutritional stress has been a leading hypothesis to account for the decline in the western SSL DPS, but one that has been difficult to test and therefore subject to considerable debate. The draft Plan's review of the data on potential nutritional stress is thorough, balanced, and incorporates the most recent information available based on analyses and publications to the present time. It acknowledges that some data collected from 2000-2005 are currently still being analyzed and therefore are not available to be incorporated into an assessment of nutritional stress during this period. These data and more current estimates of vital rates will be valuable in determining the mechanisms that are responsible for the increasing trend of the western DPS during this period.

The draft Plan acknowledges that the obstacles to evaluating the nutritional stress hypothesis include the lack of comparable physiological and behavioral data from the 1980s during the period of rapid decline, the collection of different kinds of data over time, and a poor understanding of the nutritional biology of SSL. Although acute nutritional stress has been observed in other pinnipeds, there is no evidence that this occurred during the period of rapid SSL decline during the 1980s or subsequently. Nevertheless, there is rather convincing evidence that the western SSL DPS experienced chronic nutritional stress in parts of it range during the 1980s. During the 1990s, the considerable research aimed at evaluating the nutritional stress hypothesis was inconclusive. As noted in the draft Plan this may be due partly to the inherent weakness in the study designs which typically compared a single site in each of the eastern and western DPSs thereby confounding demography trends with habitat differences such that it is

impossible to resolve these two factors. However, the review panel agrees with the Plan's assessment that modeling results suggesting depressed natality in the face of improved survival suggest "a lingering chronic impact" of some form of nutritional stress.

One of the possible explanations for nutritional stress in SSL has been called the junk-food hypothesis. This hypothesis states that changes in the assemblage of prey available to SSL due to a major climate regime shift led to poorer quality diets dominated by pollock on which SSL were unable to sustain themselves and/or to successfully reproduce. Considerable research over the past decade, mostly experimental feeding studies on captive SSL, has been devoted to understanding how SSL respond to diets of differing energy density. The panel agrees with the conclusion in the draft Plan that there is no evidence to suggest differential effects of high- versus low-fat diets on the body composition of SSL. Furthermore, Fritz and Hinckley (2005) provide evidence that discounts a major premise of the hypothesis (i.e., an overall change in the quality of food available to SSL that corresponds in timing with the population decline). They also identify some of the limitations and flaws with captive studies, some of which are reflected in the Plan whereas others are not (e.g., use of lower ranges of energy density in prey in captive studies compared to that of fish in the wild). Thus in the panel's opinion, the Plan appropriately concludes that the balance of evidence does not support the junk-food hypothesis as having negatively affected the western SSL DPS.

Ecosystem Interactions

Although this section of the Plan is brief, it does underscore the need to consider recovery of SSL in the light of the complex spatial and temporal variability in both the physical and biological features of the North Pacific Ocean. It also reminds us that human exploitation of marine mammals and fishes over the past several centuries has undoubtedly changed the environment that supports SSL and other marine mammals. Thus, ecosystems and the human influences on them have changed over time and space. This further complicates the search for answers, but it is fundamentally important to expect such changes and to design research and recovery actions in the light of them.

Conservation Measures

This section of the draft Plan presents a brief, and reasonably complete, description of measures that have been taken to conserve SSL, starting with passage of the Marine Mammal Protection Act (MMPA) in 1972. The section is organized by threat, which, while logical and consistent with the approach used in other portions of the Plan, does not allow a reader to sense the progression of protective measures that have been implemented over time. The section could be improved by adding text and perhaps a table describing the temporal sequence of major actions taken to conserve/recover SSL (e.g., passage of the MMPA, initial ESA listing, approval of first Recovery Plan, critical habitat designation, ESA reclassification, co-management agreements, fishery management measures, etc.), and how each of them addressed threats known at that time.

The sub-section on Incidental Take in Commercial Fishing provides estimates of the minimum number of animals taken in commercial fisheries (referred to as "lethal entanglements" but are actually known mortalities or serious injuries) based on NMFS stock assessment reports. The final paragraph describes the Marine Mammal Observer Program, the intention of which is to monitor takes in Category I and II fisheries, and it lists the fisheries that have been observed. However, it does not, but should, indicate the frequency with which each fishery has been

observed and the reliability of the data and extrapolations of number of animals taken. The section should also discuss which fisheries have not been observed, and how likely it is that they might be taking SSL.

There is a sub-section in the draft Plan dealing with Reduced Prey Availability due to Fisheries. As it addresses a high threat to the recovery of SSL, this subject clearly deserves careful attention. However, recognizing the depth and complexity of this issue and the fact that it has been dealt with in detail in numerous other documents, the review panel believes that the relatively brief treatment currently given in the plan is adequate.

Question 3

Does the Plan adequately present an ecologically and biologically defensible recovery strategy for the western population of SSL? Describe any shortcomings in the recovery strategy. Are there other interpretations of the ecological and biological information, and the recovery strategy derived from these interpretations, that might hold equal merit to the interpretations presented in the plan?

Review Panel Response

The Recovery Strategy section of the draft Plan makes it clear that despite the substantial efforts to determine the causes of the decline since SSL were listed under the ESA, future recovery actions "must focus on those factors that are currently impeding recovery of Steller sea lions and the actions necessary to promote recovery." The section goes on to identify four specific action items to implement as "a reasonable approach to recovery": 1) continue population monitoring and research on key threats, 2) maintain current SSL fishery conservation measures, 3) conduct an adaptive management program to evaluate fishery conservation measures, and 4) develop an implementation plan for recovery actions. These include the only priority 1 action in the Plan, and 3 actions given priority 2a (although priorities are not shown for the last 2 of the 3). While it is obvious why the priority 1 item is selected for particular emphasis in this section, it is not clear why only these 3 of the 34 total priority 2a action items in the Plan are selected. This should be changed or explained.

Overall, the panel believes the recovery strategy represents a reasonable approach. However, we have two observations. First, although adaptive management might provide benefits to SSL, we are concerned that despite many years of advocacy for an experimental approach to assessing the relative impact of threats such as commercial fisheries, it appears that there has been little progress toward designing a feasible approach or to specifying the objectives of such research/management actions. Second, we note that the draft Plan's description of an implementation plan (action 1.5) includes a call for the development of a multiple-hypothesis modeling approach, presumably following that of Wolf et al. (2006), to simultaneously examine the strength of evidence for multiple threats. Given both the empirical and modeling-based evidence that multiple threats have had a complex spatial-temporal effect on SSL dynamics, we endorse a multiple-hypothesis testing approach in moving forward with actions to recover SSL. However, it is not clear to the review panel how the proposed adaptive management will be integrated within a multiple-testing modeling approach. The panel also agrees with the observation by Goodman (Appendix, draft Plan, May 2007) that it is not clear that what the Plan is proposing is actually adaptive management in the sense of "a plan that covers all contingencies, and has verified the optimization of the path that will be chosen in response to

each possible outcomes of the experiments and monitoring, including damage control for the eventuality of experiments with unfavorable outcomes". Of course in the case of the recovery of SSL, the construction of such a plan may not be feasible at the present time. Nevertheless, the implementation plan will need to be clear about what adaptive management means in the context of SSL recovery.

An important component of the recovery strategy is the development of recovery criteria. The draft Plan explored both weight of evidence and PVA approaches to the development of recovery criteria, but used the weight of evidence approach due to limitations of the PVA model listed on pages 132 and 133. Although the recovery team chose not to use the commissioned PVA to develop recovery criteria, they did use it effectively to condition their weight of evidence approach with respect to establishing population size and growth rate benchmarks that could result in reclassification as threatened or delisted. The discussion of the difficulties in constructing a PVA for the western DPS also served to highlight gaps in knowledge of the population dynamics and ecology of this species.

Although the weight of evidence approach to developing recovery criteria is necessarily somewhat subjective, the panel feels that the demographic recovery criteria used in the plan are reasonable as they capture the need for sustained population increase and that this increase be widely distributed throughout the population. We note that the demographic criteria for delisting appropriately make use of the recent estimate of rate of increase of the eastern DPS (Pitcher et al. 2007), which is the only measured rate of increase for a SSL population and therefore the best scientific information available. The descriptions of recovery factor criteria for reclassification and delisting are reasonable and thorough.

Question 4

Are the recovery actions described within the Plan appropriate to meet recovery goals? Are the recovery actions consistent with the SSL life history information, population dynamics, and threats assessment presented in the Plan? Are there other recovery actions that have not been included in the Plan that should be included to achieve recovery? Is there sufficient evidence in the scientific literature, as presented in the plan, to suggest that the recommended recovery actions will work?

Review Panel Response

In general, the review panel believes that the recovery actions presented in the Plan should promote the recovery of the western SSL DPS. The panel believes that the recovery actions are consistent with current knowledge of SSL ecology and population dynamics and the threats facing this segment of the population. However, as the factors limiting recovery are presently poorly understood, the panel cannot be certain that there are not other actions that might be appropriate.

The draft Plan adopts three general principles to guide recovery actions: 1) NMFS will work closely with partners to implement the plan; 2) carefully designed monitoring will be essential to determine effectiveness of recovery actions; and 3) implementation should be responsive to new information. In addition to these, the review panel would suggest that management actions be implemented in a manner that will permit evaluation of their efficacy. Given the large number of actions listed, the panel has commented on only those considered of the highest priority and

those where we believe that spending resources may not pay large dividends in terms of recovery. The panel also notes that many of the actions involving the collection of biological samples can be achieved with little additional marginal cost given that animals need to be live-captured for higher priority actions.

Action 1 – Baseline population monitoring

Strictly speaking population monitoring is not a recovery action. However, the effectiveness of recovery actions will for the most part be evaluated by spatial and temporal changes in the indices used to estimate population size and trends. Thus, the review panel agrees that continued population monitoring, using standardized methods, should be considered a high priority recovery action. While there is no doubt that monitoring population abundance is essential, those data alone provide little understanding of the mechanisms driving change. Thus, we agree that, to the extent possible, continued efforts to estimate survival, natality, and dispersal are needed to understand population responses to natural environmental variability, human influences, and recovery actions. Therefore, the review panel agrees with the draft Plan's recommendation that the current branding and resighting of permanently marked individuals should be continued at multiple sites throughout the western DPS. However, the panel also believes that action 1.2.3 (investigating demography using medium format aerial photographs) should be given special attention since it is non-invasive and potentially could provide greater understanding of spatial and temporal changes in vital rates.

By contrast, the review panel is not convinced that continued effort to monitoring health and body condition of individuals (actions 1.3.1 and 1.3.2) will directly promote the recovery of SSL. At a minimum, the Plan should describe the specific health and condition parameters that should be monitored, and provide rationale for how such monitoring will contribute to population recovery. On the other hand, the development of methods to easily determine the reproductive status of adult females would facilitate efforts to estimate natality.

The review panel also endorses continued efforts to improve live-capture methods (action 1.4.1), particularly those that will permit the safe capture of older and larger individuals to fill gaps in our knowledge of foraging ecology and vital rates. As above, the panel is unconvinced that much effort should be devoted to the development of non-lethal sampling techniques to assess health (action 1.4.2) given the presumed low risk of disease and contaminants in limiting the recovery of SSL.

The review panel agrees with the need to develop an implementation plan (action 1.5) and that it should be guided by the principles of multiple causation affecting population dynamics and long-term consistent monitoring. To these principles, we would add the need for the application of management actions in a manner that permits evaluation of efficacy. Hennen (2006) concluded that the efficacy of fishery exclusion zones around SSL rookeries cannot be evaluated because all rookeries were given the same treatment. Given the over-riding importance of this recovery action, the panel also believes that this action should be given priority 1 in the draft Plan.

Action 2 – Insure adequate habitat and range for recovery

The review panel agrees that ensuring adequate habitat for SSL is an essential recovery action. However, the panel is unaware of analyses that would support the claim on page 152 of the draft Plan that the currently designated critical habitat "appears to generally have been effective."

Given the importance of marine habitat to recovery and the considerable increase in our understanding of SSL foraging behavior and distribution, the panel believes that analyses of the efficacy of critical habitat and the subsequent re-evaluation of critical habitat should be given higher priority.

As noted in the draft Plan, food is a critical part of SSL marine habitat. Thus, determining what SSL consume has been and will continue to be an important component of research and monitoring. Nevertheless, it is a daunting task to estimate the diet of most marine mammal species. Given the broad geographic distribution and often difficult and remote sampling sites, SSL are certainly no exception. As the different methods of estimating diet have different strengths and weakness (i.e., biases), the review panel supports the simultaneous use of different methods to build up a robust understanding of the important features of the diets of different age and sex classes (actions 2.3.1 and 2.3.2).

The geographic distribution of forging defines the spatial characteristics of SSL marine habitat. Telemetry data have been crucial in establishing certain conservation measures. Therefore, the review panel agrees that continued deployment of telemetry instruments (action 2.3.3), especially those that provide better quality positional data, should be a high priority. Although information in the draft Plan suggests the need for finer temporal and spatial scale data on foraging SSL, the use of newer statistical methods, such as state-space behavioral switching models (e.g., Jonsen et al. 2005), could significantly improve our understanding of SSL foraging using the considerable data currently in hand. Andrews et al. (2002) first highlighted the added benefits of combining stomach temperature telemetry data with satellite location data to determine where and when successful foraging takes places. Although there are challenges to be overcome in this type of research (primarily retention of the stomach temperature transmitter), studies on other species (Austin et al. 2006) suggest that further research could determine not only where SSL dive, but where and when they successfully feed.

The review panel notes that there are two other technologies not mentioned in the plan that might also be used to better understand the foraging ecology of SSL. One is the use of animal-borne video cameras to calibrate probable fish capture with dive characteristics to enhance interpretation of diving data and to determine the differential costs of prey capture as a function of prey type. The other is the use of two-way acoustic tags that could be used in combination with tagging prey to determine prey encounter rates by SSL. Although the review panel believes there is need to determine better the spatial and temporal patterns of foraging for all age-sex classes, given the evidence that juvenile survivorship has improved to the levels of the mid 1970s and the apparent continued decline in birth rates suggesting lingering chronic nutritional stress affecting pregnant females, higher priority should be given to deployments on adult females. The panel also believes that to the extent possible telemetry studies should be conducted in conjunction with efforts to assess the prey available to SSL on the same spatial and temporal scales as the foraging activity.

The strongest inferences about the effects of environmental variability and commercial fisheries on habitat use, from the accumulated wealth of diving and positional data on SSL, will come through the joint analysis of data from different studies. Therefore the panel supports the recommendation to synthesize all such studies into a common database (action 2.3.4). Earlier reviews of SSL recovery efforts noted the inadequate coordination of telemetry studies and results among the various research organizations. Such an effort will increase the usefulness of the data and the ability to conduct retrospective analyses.

As stated in the draft Plan, the dynamics of SSL populations are influenced by natural environmental variability and by human actions. These factors often operate simultaneously to affect survival or reproduction. One of the greatest challenges in implementing effective recovery actions is to distinguish the relative effects of natural and human-induced factors. The multiple-hypothesis, statistical modeling approach used by Wolf et al. (2006) may offer an effective way to proceed. But to use this approach effectively will require a better understanding of the key ecosystem components upon which SSL depend (actions 2.4.2 and 2.4.3) or by which they are affected (e.g., predation).

The draft Plan describes the need for continued research on SSL bioenergetics (action 2.5). SSL, like all other animals, need to acquire adequate food energy and essential nutrients for maintenance, growth, and reproduction. Bioenergetics is the study of those requirements and how they vary. Although relatively little was known 10 years ago specific to SSL bioenergetics, research in the intervening years has provided a wealth of SSL-specific information on metabolic rates, the effects of diets on metabolism and changes in body energy stores, and other topics. Several detailed bioenergetics models have been constructed using these new findings. These models provide estimates of age-specific food requirements and can be used to explore the consequences of variation in food intake on condition and survival. Given what we have learned, it seems to the review panel that more research in this area is unlikely to play a major role in promoting the recovery of SSL. This is not to say that no further research is needed to understand better SSL bioenergetics, but rather that such research ought to be justified primarily for reasons other than to recover SSL.

The threats assessment concluded that the only high threats to recovery of SSL result from nutritional limitations, so action item 2.6 is a crucial part of the draft Plan. Since the only factor affecting the SSL prey base that is subject to management is commercial fishing, the central question is how can commercial fisheries be managed to ensure that their actions do not limit SSL reproduction and survival? There are essentially two ways in which managers can proceed to answer this question. The first is an observational/descriptive approach in which an attempt is made to gather detailed information on what comprises an optimum SSL diet; what potential prey species are available in each specific locality and time of year; how successful SSL are likely to be at capturing each prey species at varying densities; how prey densities are affected by environmental conditions, natural competitors, and commercial fishing; and how fishing practices can be manipulated to ensure that SSL can acquire a diet that is as close to the optimum as practicable. Several action items in this section (e.g., 2.6.1, 2.6.2, 2.6.3, 2.6.5, and 2.6.7) are designed to provide data needed to support such an approach. However, the review panel believes that, even given the extraordinary amount of funding that has been made available for SSL recovery in recent years and the advances in knowledge that have accrued, such an approach is unlikely to yield a conclusive and comprehensive understanding of how to manage commercial fisheries so as to minimize their impacts on SSL. Put simply, the Gulf of Alaska and Bering Sea/Aleutian Islands ecosystems are too large, too diverse, too complex, and too variable to expect that science can collect all of the data needed to support management models that incorporate all of these factors and their interactions.

The alternate approach is to use field experiments, adaptive management, and multiple-hypothesis statistical models to assess how SSL respond to various levels and types of fishing on species that comprise their prey base, as described in actions 2.6.4 and 2.6.8. While recognizing the numerous difficulties involved in such an endeavor, the review panel endorses that approach.

The ability of commercial fishing to produce localized and regional depletion of prey that might affect SSL foraging success and survival are lingering questions. Although there has been limited experimental effort to investigate such effects, much more needs to be done. Thus, the panel believes this type of research deserves higher priority. We note, however, that managers will need to remain cognizant of the need to foster continued recovery of the western DPS (e.g., action 2.6.6), while considering the full range of possibilities where experimental manipulations may be made (e.g., experiments manipulating fishery removals could be conducted within the recovered eastern DPS).

The review panel agrees that it is essential that all fisheries that might impact the prey base of SSL, including those managed by the State of Alaska, be evaluated and managed in a manner that will have negligible impacts on population recovery. We therefore agree with the intent of actions 2.6.9 and 2.6.10, but are unclear about the differences between the two items and suggest that they might be combined.

Action 3 – Protect from over utilization for commercial, recreational, scientific, or education purposes

The review panel agrees with the threats assessment in the draft Plan that taking of SSL for commercial, recreational, scientific, or educational purposes pose a low threat to recovery, if they are a threat at all (see response to question 1 above). Nonetheless, the inclusion of actions 3.1-3.5 that would continue efforts to minimize such taking as much as possible is reasonable, and we believe that in general they are adequately described. With regard to monitoring incidental take in fisheries, we note that while the Alaska Marine Mammal Observer Program has collected data on incidental takes in some Category II state-managed fisheries, the level of coverage and frequency with which they have been observed have been marginal. Furthermore, some fisheries that operate with gear that could take SSL (e.g., gillnets and purse seines) have never been observed. This section should be revised to provide specific suggestions for improvements to this observer program. Also, from what is stated in the draft Plan and published analyses (Credle et al. 1994), it is apparent that voluntary reporting of takes by fishermen is not a reliable method for gathering data, and rather than encouraging such efforts it would be better for the Plan to simply acknowledge that fact.

Action 4 – Protect from diseases, contaminants, and predation

There is no evidence that diseases have played or are playing an important role in the dynamics of the western DPS of SSL. However, the limited data do suggest a need to examine the possible role of some infectious diseases in synergistically contributing to lack of recovery through differentially affecting animals already nutritionally stressed. Disease and/or parasitism, could be contributing to the possibly chronically stressed females that lead to relatively low birth rates. Also, the possibility of an epizootic causing large scale mortality of SSL, as has happened with pinnipeds elsewhere, cannot be discounted. Nevertheless, the panel is unconvinced that epidemiological surveys (action 4.1.1), large-scale parasite evaluations (action 4.1.2), or immune function testing (action 4.1.3) are likely to be of much value in promoting the recovery of the western DPS. Therefore, the assignments of secondary priorities to these and other actions relating to disease seem appropriate given the way they are currently formulated as descriptive surveys. The review panel would consider the development of specific research hypotheses to investigate, for example, the role of disease or parasitism in low natality in a more favorable light.

There is no evidence that contaminants (action 4.2) were a major factor in the decline or are limiting the recovery of the western SSL DPS. Nevertheless, we acknowledge that knowledge of the impact of contaminants on SSL health and population status is limited. Contaminant effects could be operating at a level that might not affect normally healthy animals, but could have a synergistic affect on animals already stressed by nutritional factors. Nonetheless, the review panel believes the proposed actions for addressing contaminants should be given low priority.

Predation of SSL by killer whales (*Orcinus orca*) is known to occur and has been hypothesized as an important cause of the decline of the western DPS. The strength of the argument is based largely on modeling results that show such an effect is feasible. There are few empirical data to test this hypothesis and so it is simply not known if killer whale predation was a significant factor in the decline or is currently limiting recovery. Nevertheless, top-down effects of predators, such as killer whales, can have significant effects on prey populations. Therefore, it seems prudent to attempt to learn more about the effect of killer whales on the future dynamics of SSL populations. Of the proposed actions, the panel agrees that higher priority should be given to improving estimates of the diets of transient (mammal eating) killer whales (action 4.3.2), their distribution (action 4.3.5) and abundance (action 4.3.6). The panel believes that these new data should be incorporated into multi-species population dynamic models to evaluate the potential impact of predation on the recovery of SSL. In this, we differ somewhat from action 4.3.7, which seems to call for the development of bioenergetic simulation models. Such models have been constructed in the past, but they can only answer questions of feasibility. To the extent that killer whale predation is perceived as a real threat to recovery, we believe it is most important to gather empirical data to estimate predation rates and how these might vary throughout the geographic range of the western DPS. The review panel notes that estimating killer whale predation rates could be a prohibitively expensive undertaking in light of what seems to be a stable or recovering stock. Furthermore, it is unlikely that new information on the importance of killer whale predation would be used to take measures to enhance SSL recovery. Therefore, resources devoted to this research should be balanced against how new information would be used in recovering SSL. In this light, the review panel believes that a research program on captive killer whales (action 4.3.1) should be given a lower priority than indicated in the draft Plan.

Action 5 – Protect from other natural or anthropogenic factors and administer the recovery program

This section includes several items relating to general programmatic needs for SSL recovery. Items addressed in actions 5.1 and 5.2 are ones that the review panel has recommended be considered as not a threat to recovery (see response to question 1 above) and we therefore would recommend they be given very low priority. Actions 5.4, 5.5, and 5.6 address issues of administration, coordination, and outreach which are essential parts of the SSL recovery program that should be fully supported.

Action 5.3 (monitoring causes of mortality) addresses an important potential source of information on SSL and as such deserves substantive attention. This action, combined with action 5.7.3 (sampling subsistence harvest), provides the opportunity for researchers to access a considerable number of dead sea lions, the analysis of which could provide insights into not only causes of death (by age, sex, geographical location, etc.), but also other biological information such as diets, growth rates, health status, body condition, etc. Clearly, reasonably complete

inspection and sampling of stranded and harvested animals has not yet been achieved, and steps should be taken to improve both of these programs. While there may be substantial problems with accessing stranded animals especially in remote parts of Alaska, the same is not the case with animals harvested by Alaska Natives. Actions 5.7.1 and 5.7.3 should be revised to require mandatory reporting and sampling of Native-harvested SSL, as is done for other marine mammal species in the Fish and Wildlife Service's Marking, Tagging, and Reporting Program

Question 5

Are the recovery tasks in the Plan's Implementation Schedule appropriately prioritized to facilitate recovery?

Review Panel Response

Overall, the review panel believes that the priorities assigned in the Plan to the various recovery actions are appropriate to facilitate recovery of the western SSL DPS. However, the panel's priorities differ from the draft Plan on some specific actions as discussed below.

Section E sets out the priority assigned to each of the 78 recovery actions identified in the draft Plan. Those of priority 1 must be done to prevent extinction. Those of priority 2 are actions that must be taken to prevent further decline in population or habitat, subdivided into 2a – of primary importance, and 2b – of secondary importance. Priority 3 is given to all others actions needed to provide full recovery.

Priority 1 is assigned only to the continued monitoring of pups and non-pups (action 1.1.1). Although the review panel agrees that this is among the highest priorities, we believe that it is equally important to obtain a better understanding of changes in the vital rates (action 1.2.1) that are responsible for the spatial and temporal changes in abundance and to incorporate these new data into a modeling framework that not only can help guide future research and management actions, but also help discriminate among the competing hypotheses advanced to account for population changes. This modeling framework is alluded to in actions 1.5 and 2.4.3 (ability to distinguish natural and human effects on SSL), but is not given the prominence in the plan we believe it deserves. The panel believes both of these actions should be priority 1 in the Plan. As discussed earlier, the panel believes that action 1.5, development of an implementation plan, should also be given priority 1.

Given what has been learned over the past decade, the review panel believes that the priority 2a/2b given to further bioenergetics research (actions 2.5.1- 2.5.4) on SSL should be changed to priority 3. As noted earlier, it is not that such research should not be done, but it seems difficult to justify such expensive research as a recovery action when a case has not been made for how the information would be used to promote recovery.

There are several recovery actions that relate to assessing the impact of fisheries or fisheries management regulations on SLL habitat and food availability (actions 2.6.4, 2.6.6, 2.6.7 and 2.6.8), each of which is given priority 2a. Although, the panel agrees with this assessment, we also recommend that they be dealt with in an integrated manner and not as separate actions. Given the complex interaction among natural and human forcing of SSL dynamics, a multiple-hypothesis approach, as envisioned in action 1.5, seems most likely to provide insight that can usefully guide future recovery actions.

As discussed above, the review team believes that an analysis of the efficacy of critical habitat and the re-evaluation of what habitat has been officially designated (action 2.1) should be given priority 2a.

It is plausible that killer whale predation could have had played a role in the decline and could be a limiting factor in recovery of the western SSL DPS. Therefore, the panel believes there is merit in gaining a better understanding of the impact of killer whale predation on the current and future dynamics of SSL and that the priority given to actions 4.3.2, 4.3.4, and 4.3.6 are appropriate. On the other hand, these actions will be expensive, the resulting estimates of predation rate will be subject to considerable uncertainty, and it is difficult to see how the information would be used to directly foster SSL recovery. Thus, the panel believes the implementation plan will have to carefully consider the priority given to this research, especially if funds are insufficient to address other recovery actions that might have a more direct effect on recovery. As noted above, the panel does not believe that a program to study the bioenergetics and physiology of captive killer whales is warranted as a SSL recovery action, and therefore recommends that action 4.3.1 should be given priority 3.

As discussed under question 1, there are five potential threats to the western DPS identified in the draft Plan that the review team believes should be considered as not currently a threat to recovery. As such, we believe that action items relating to all those topics should all be given priority 3, as is currently done in the implementation schedule for three of them—illegal shooting, disturbance from vessel traffic and tourism, and disturbance from research. The review panel recommends that all action items relating to contaminants (actions 4.2.1-4.2.4) and entanglement in marine debris (actions 5.1 and 5.2) should also be given priority 3.

Question 6

Does the information in the Plan appropriately support the recovery criteria described in the Plan? Are the recovery criteria consistent with and do they meet the requirement of the Endangered Species Act (ESA) to ensure the conservation of the species (i.e., recovery and ultimate delisting: “conservation” as defined in the ESA [16 USC Section 1532(3)])?

Review Panel Response

The review panel believes that the best available information was used to develop recovery criteria and that the information contained in the revised plan reasonably supports those criteria. The recovery criteria are consistent with and do appear to meet the requirements of the ESA to ensure the conservation of the species.

Although there is a growing belief that there is a need to develop quantitative criteria and more consistency in evaluating recovery under the ESA, and that PVA is one way to do this (DeMaster et al. 2004, MMC 2007), the rationale provided by the recovery team for using the weight of evidence approach informed by the PVA commissioned by the team, rather than using the PVA solely, makes sense at this time. This is particularly true in light of the lack of data that would allow the PVA to model the SSL as a meta-population and include density-dependence of vital rates. Moreover, the long time to recovery means that these recovery criteria can be re-visited in the future and adjusted appropriately as new data become available. At that time it may be appropriate to reconsider the use of the PVA to establish new recovery criteria.

The review panel believes that the draft Plan should specify the probability level at which the null hypotheses, corresponding to the demographic criteria, would be rejected. In the absence of this information, the demographic criteria are incomplete. The panel also feels that it would be useful to state if it is intended that the 15-year period of average positive growth is associated with an initial reference year. Finally, the panel notes that failure of recovery of the western DPS of SSL could be the result of synergy among multiple threats. Although there are references to combined effects in the threats-based criteria, there needs to be a clear statement requiring satisfaction that cumulative impacts of multiple smaller effects are not likely to recur despite minimizing individual threats.

Question 7

Does the Plan fairly weigh competing hypotheses on the causes of the decline, and/or lack of recovery, of the western population of SSL?

Review Panel Response

The review panel believes that the draft Plan has fairly weighed the evidence and the arguments for and against competing hypotheses on the causes of the decline. There are two major classes of proposed causes of the decline and failure to recover for the western SSL DPS. These are food limitation (i.e., nutritional stress mediated by environmental variability and/or competition with fisheries) and direct mortality (i.e., intentional and illegal kills, fisheries by-catch, subsistence or commercial harvests, and/or killer whale predation). The Plan correctly notes, in the panel's opinion, that in most cases the data are too limited to provide strong tests of these hypotheses. However, the preponderance of evidence fails to support two popular hypotheses – the junk food hypothesis for food limitation and the sequential megafaunal collapse for direct mortality. Nevertheless, the draft Plan clearly states that these conclusions do not preclude either factors relating to prey or killer whale predation from playing a role in limiting recovery of the western DPS of SSL. The draft Plan covers the potential of fisheries competition fairly, noting the circumstantial evidence in favor of an impact (Hennen 2006), but also noting that additional research, including experimentation, will be needed to determine the impact of fisheries on SSL. Finally, several recent analyses (e.g., Demaster et al. 2004; Wolf et al. 2006; Guenette et al. 2007) of the evidence supporting the major hypotheses conclude that it is likely that both food limitation and direct mortality played a role in the decline and subsequent lack of recovery, though the relative importance of the various factors still needs to be established. This conclusion underscores the importance of simultaneously testing multiple hypotheses in the search for answers.

Summary Comments

The reasons for the dramatic decline of the western DPS of SSL may never be known with any certainty. Clearly, some conservation measures (e.g., protection from killing) have had positive impacts on the dynamics of SSL, but the benefit of others (e.g., critical habitat and fishery conservation measures) remains uncertain. Nevertheless, the recent increase in numbers in this segment of the population is a welcome development. This increase has not been observed

uniformly across the western portion of the U.S. population, underscoring the need to recognize that limiting factors must differ either in nature or magnitude throughout the range. The panel believes that this fundamental realization is captured in the draft Plan and that the application of recovery actions and their evaluation within this context should provide the best opportunity to both understand and ameliorate the threats limiting the recovery of the western DPS of SSL.

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