National Marine Fisheries Service
Endangered Species Act Section 7 Re-Initiated Consultation
Biological Opinion

Agency: Permits, Conservation, and Education Division of the Office of Protected Resources, National Marine Fisheries Service

Activities Considered: Full Implementation of the Preferred Alternative of the Programmatic Environmental Impact Statement (PEIS) for Research on Steller Sea Lions and Northern Fur Seals Pursuant to the Marine Mammal Protection Act and Section 10(a)(1)(A) of the Endangered Species Act

Consultation Conducted By: Protected Resources Division, Alaska Region

Approved By: Kaja Brix For D. Mecum

Date: 29 July 09

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1. BACKGROUND AND CONSULTATION HISTORY

The Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531-1544), amended in 1988, establishes a national program for the conservation of threatened and endangered species of fish, wildlife, plants, and the habitat on which they depend. Section 7(a)(2) of the ESA, requires that each federal agency shall insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species, or destroy or adversely modify critical habitat of such species. When a federal agency's action "may affect" a protected species, that agency is required to consult formally with the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service, depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR 402.14(a)). Federal agencies are exempt from this general requirement to formally consult if they have concluded that an action “may affect but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS or the U.S. Fish and Wildlife Service concur with that conclusion (50 CFR 402.14(b)).

This document is the product of a consultation pursuant to section 7(a)(2) of the ESA and implementing regulations found at 50 Code of Federal Regulations (CFR) Part 402. For the actions evaluated in this consultation, the action agency is NMFS Permits, Conservation, and Education Division of the Office of Protected Resources (Permits Division) and the consulting agency is NMFS Alaska Region, Protected Resources Division (PRD). This document evaluates the Permits Division’s proposal to fully implement the Research Permits program as described in the Preferred Alternative (Alternative 4) of NMFS’ 2007 Final Programmatic Environmental Impact Statement (FPEIS) on Steller Sea Lion and Northern Fur Seal Research for any subsequent permit applications. The new permits that would be issued under the preferred alternative of the Final PEIS would be valid up to the five year limit under their regulations for marine mammal research.

By letter of 26 February 2009 to the Endangered Species Division, the Permits Division requested reinitiation of consultation under Section 7 on their proposal to fully implement the Research Permit Program as described in the Preferred Alternative of their 2007 Final Programmatic Environmental Impact Statement (FPEIS) on Steller Sea Lion and Northern Fur Seal Research. Reinitiation was required because the 2007 biological opinion was specific to the batch of permit applications received for activities covering 3 field seasons and, as clarified in the request for reinitiation memo (NMFS 2009:1) “did not broadly cover issuance of future permits under the preferred alternative of the EIS”.

The request for consultation was accompanied by the document entitled “Summary Document Steller Sea Lion and Northern Fur Sea Research Final Programmatic Environmental Impact Statement” (Summary Document), dated January 2009, the document entitled “National Marine Fisheries Service Policy and Guidance for Implementation of the Steller Sea Lion and Northern

Fur Seal Research Permits and Grants Programs under the Preferred Alternative of the 2007 Final Programmatic EIS (Policy and Guidance Document) (NMFS 2008) (available at http://www.nmfs.noaa.gov/pr/pdfs/permits/ssl_eis_policy.pdf), and the document entitled "Report of the Independent Review Panel on the National Marine Fisheries Service's Implementation of the Permit Program for Research: Steller Seal Lion and Northern Fur Seal Case Study" (Report of the Independent Panel) provided as Appendix C of the Policy and Guidance Document, and the NMFS' 2007 Final Steller Sea Lion and Northern Fur Seal Research Programmatic Environmental Impact Statement (FPEIS) (NMFS, 2007). The purpose of this consultation is to evaluate the effects of the implementation of the Preferred Alternative (Alternative 4) as described in the FPEIS, with implementation clarified and refined in the Policy and Guidance Document.

By Memo dated 15 May 2009 the Director of the Office of Protected Resources (OPR) requested that the Assistant Administrator for Fisheries approve delegation of authority to the Alaska Region for Section 7 Signature for Re-Initiation of Section 7 Consultation on the PEIS for Research on Steller Sea lions and Northern Fur Seals. This delegation was signed by the Assistant Administrator on 15 May 2009 in a memorandum to the Regional Administrator, AKR.

The species of concern in this formal Section 7(a)(2) consultation are as follows:

- Western Population of Steller Sea Lions (*Eumetopias jubatus*; listed as threatened on November 26, 1990 [55 FR 40204]; listed as endangered on May 5, 1997 [62 FR 30772]; critical habitat designated on August 27, 1993 [58 FR 45269])
- Eastern Population of Steller Sea Lions (*Eumetopias jubatus*; listed as threatened on November 26, 1990 [55 FR 40204]; critical habitat designated on August 27, 1993 [58 FR 45269])

Based on the best available information (see NMFS 2008a, b) about the current range and habitat use of the Cook Inlet distinct population segment of beluga whale it is highly unlikely individuals or groups of CIB whales will be exposed to potential stressors associated with this action:

- While belugas were once abundant and frequently sighted in Lower Cook Inlet during summer, they are now primarily concentrated in the upper Inlet. This constriction is likely a function of a reduced population seeking the highest quality habitat that offers the most abundant prey, most favorable feeding topography, the best calving areas, and the best protection from predation (NMFS 2008a).
- Steller sea lion surveys and boat based field research that could occur in the far southern areas of the Lower Inlet occur in the summer.
- There are not Steller sea lion haul out or rookery sites or Northern fur seal haul-out or rookery sites in the upper Cook Inlet (e.g., see figure 1 of Fritz et al. 2009). Thus, there is not focused Steller sea lion or Northern fur seal research in this area. Aerial surveys of Steller sea lions do not extend into the upper inlet (see Figure 2 of Fritz et al. 2009). We are not aware of any indirect or interrelated pathways by which Cook Inlet beluga whales could be exposed to stressors from research on the Steller sea lion or Northern fur seal.

For this reason (unlikely exposure to stressors associated with the action), we do not develop the analysis of potential effects of this action on Cook Inlet beluga whales. We conclude that the proposed action is not likely to affect Cook Inlet beluga whales. However, NMFS (2008a) also concluded that "an expanding population would likely expand its range back into the lower Inlet". At present, there is no indication that the population is expanding and that summer use of this area is likely to occur. If information becomes available that indicates that the habitat use of belugas is expanding into areas of the lower Cook Inlet or that Cook Inlet beluga whales are expected to occur in areas where stressors due to Steller sea lion or Northern fur seal research may occur, NMFS Permits division should re-initiate consultation on this action.

Thus, this consultation considers whether the effects of these actions are likely to jeopardize the continued existence of these two populations of Steller sea lions or cause the destruction or adverse modification of their designated critical habitat.

For all other listed species in the action area, NMFS (2007) made a determination of either "no effect" or "not likely to adversely affect." The Summary Document included as part of the re-initiation package by the Permits Division (NMFS 2009b:9) summarized relevant new information. It stated that:

> "Sections 3.2.3 – 3.2.7 of the PEIS described the terrestrial and marine mammals that could occur in the project area addressed in the PEIS. These sections included descriptions of killer whales (3.2.3), other ESA-listed species (3.2.4), other marine mammals (3.2.5), fish (3.2.6), and other marine species (3.2.7), and ecosystem interactions (3.2.8). Some species, such as killer whales, have been subject to a substantial amount of research since 2007 but the PEIS found no substantial effects of SSL and NFS research on any of these other species. NMFS does not foresee any significant changes in the nature of effects of SSL or NFS research on these other species. Updates to the baseline information on other species are not warranted. "

As detailed further in the introduction to the Status of Species section, we have reviewed the information in the Summary Document, the best available scientific and commercial information available about these other ESA-listed species and listed habitats, and the differences between potential stressors associated with the limited implementation of the proposed action consulted on in 2007 and the full implementation being consulted on here. We have concluded that additional formal consultation on these other listed species is not warranted. For further information on other ESA-listed species not considered here, see the FPEIS prepared by Permits Division (NMFS 2007) and the Summary Document (NMFS 2009b).

This biological opinion (Opinion) and incidental take statement were prepared by NMFS PRD in accordance with section 7(b) of the ESA, and implementing regulations at 50 Code of Federal Regulations (CFR) Part 402. The opinion is based on an evaluation of both the direct and indirect effects of the action on listed species and their critical habitat, together with the effects of other activities that are interrelated or interdependent with that action. The opinion presents NMFS PRD's review of the status of the listed species considered in this consultation, the condition of the critical habitat, the environmental baseline for the action area, all the effects of the action as proposed, and cumulative effects (50 CFR 402.14 (g)). For the jeopardy analysis, NMFS PRD analyzed those combined factors to determine whether the proposed action is likely to appreciably reduce the likelihood of survival and recovery of the affected listed species. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the analysis with respect to critical habitat.

If NMFS PRD determines that the action under consideration is likely to jeopardize the continued existence of an ESA-listed species or destroy or adversely modify designated critical habitat, we must identify any reasonable and prudent alternatives for the action that will enable the action agency to avoid jeopardy and destruction or adverse modification of critical habitat and meet other regulatory requirements (50 CFR Part 402.02).

NMFS PRD developed this biological opinion after reviewing information provided in many sources, including, but not limited to the following: the Summary Document; the 2007 PEIS; the Policy and Guidance document (including appendices); previous biological opinions and National Environmental Policy Act (NEPA) documents related to this action, including the 2007 Biological Opinion on Steller sea lion and Northern Fur Seal Research transmitted by the Endangered Species Division of the Office of Protected Resources; the 2007 Decision Memorandum (from the Chief of the Permits Division to the Director of the Office of Protected Resources) relating to 13 applications for Scientific research on Steller sea lions and northern fur seals; the 2008 Final Revised Steller Sea Lion Recovery Plan (NMFS 2008); comments on the 2007 permit applications submitted by the Marine Mammal Commission (MMC), Animal welfare organizations, and members of the public; current permits for research on Steller sea lions and Northern fur seals; permit applications for future Steller sea lion and Northern fur seal research currently under review by the Permits Division; proposals for research on Steller sea lions submitted to the Alaska Region grants office; annual, final and special reports submitted by permit holders as part of the terms of the permit; the Conservation Plan for the Eastern Pacific Stock of the Northern Fur Seal (NMFS 2007); NMFS Steller Sea Lion and Northern Fur Seal Research EIS Public Scoping Report (URS 2005); listing documents for the Steller sea lion and its critical habitat and for Cook Inlet beluga whales; stock assessments published pursuant to the MMPA (Angliss and Allen 2008); biological opinions relating to impacts from other actions on Steller sea lions (e.g., NMFS 2001, 2003); published and unpublished scientific information on the biology and ecology of threatened and endangered sea lions and other listed species, published and unpublished information relevant to understanding the potential effects of the proposed research on listed species in the action area, published and unpublished information relevant to assessing the environmental baseline and cumulative effects; and other sources of information gathered and evaluated during consultation on the proposed activities (cited herein). A complete administrative record of this consultation is on file at NMFS Alaska Regional Office Alaska (PCTS Tracking number: F/FPR/2006/05848-R).

This document represents NMFS' biological opinion (Opinion) on the issuance of Steller sea lion and Northern fur seal research program's proposal to issue permits for federally funded research on Steller sea lions and Northern fur seals, and whether this research program satisfies NMFS' obligations pursuant to section 7(a)(2) of the ESA of 1973, as amended.

Consultation History

In 2007, NMFS Office of Protected Resources Permits, Conservation, and Education Division (Permits Division) in cooperation with NMFS Alaska Regional Office, Grants Program (Grants Program), initiated formal consultation with the Office of Protected Resources' Endangered Species Division (Endangered Species Division) on their proposal to implement the Preferred Alternative of the Programmatic EIS (PEIS) to disperse funds and authorize research on Steller sea lions and Northern fur seals on lands and in waters of the United States. In this consultation, the Permits Division acted as the lead agency and fulfilled consultation responsibilities for the Grants Program (see 50 CFR 402.07). Consultation was originally conducted on the Draft PEIS and a batch of associated permit applications in 2007. Based on the consultation process, the Permits Division limited implementation of the preferred alternative by issuing permits that were valid for three spring field seasons (NMFS 2007). The 2007 biological opinion was specific to the batch of permit applications received and did not broadly cover issuance of future permits under the preferred alternative of the EIS.

On June 13, 2007, NMFS' Permits Division committed to engaging in a comprehensive program review using independent experts to develop a stronger and clearly articulated decision framework for making permit decisions and a research implementation plan for studies on Steller sea lions.

On June 18, 2007, NMFS Endangered Species Division of the Office of Protected Resources (NMFS 2007) issued its Biological Opinion on "Activities authorized on Steller Sea Lions and Northern Fur Seals Pursuant to the Marine Mammal Protection Act and Section lO(a)(l)(A) of the Endangered Species Act." The body of that opinion stated that the opinion was on the "Steller sea lion and Northern fur seal research program's proposal to issue permits for federally funded research on Steller sea lions and Northern fur seals for this three-year period." This opinion concluded that:

> "…the research program, as proposed, is not likely to jeopardize the continued existence of the endangered western stock (or population) of Steller sea lion DPS or the threatened Steller sea lion DPS. Critical habitat for this species has been designated for listed Steller sea lions, however, the proposed action is not expected to affect that area and no destruction or adverse modification of that critical habitat is anticipated."

In the transmittal memo for the 2007 opinion, NMFS stated that:

> The attached document summarizes the best scientific information available on the potential impacts of proposed research activities on Steller sea lions and other listed species within the action area. Our review finds that the proposed activities would have no effect on green sturgeon, and white abalone, and may affect, but is not likely to adversely affect the following listed species and their critical habitat (where designated):
> California coastal Chinook salmon, Central Valley spring run Chinook salmon, Lower Columbia River Chinook salmon, Upper Columbia River spring-nm Chinook salmon, Puget Sound Chinook salmon, Sacramento River winter-run Chinook salmon, Snake

River fall-run Chinook salmon, Snake River spring/summer-run Chinook salmon, Upper Willarnette River Chinook salmon, Columbia River Chinook salmon, Hood Canal summer-run chum salmon, Central California coast coho salmon, Lower Columbia River coho salmon, Southern Oregon and Northern California coast coho salmon, Ozette Lake sockeye salmon, Snake River sockeye salmon, Central California coast steelhead, Puget Sound steelhead, Snake River steelhead, Upper Columbia River steelhead, Southern California steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, Upper Willamette River steelhead, Northern California steelhead, South-Central California coast steelhead, and California Central Valley steelhead, green sea turtle, loggerhead sea turtle, leatherback sea turtle, olive ridley sea turtle, blue whales, bowhead whales, sperm whales, sei whales, humpback whales, fin whales, whales, northern right whales, and southern resident killer whales, and Guadalupe fur seals.

On February 26, 2009 the Permits Division requested reinitiation of consultation under Section 7 on their proposal to fully implement the Research Permit Program as described in the Preferred Alternative of their 2007 Final Programmatic Environmental Impact Statement (FPEIS) on Steller Sea Lion and Northern Fur Seal Research. Reinitation was required because the 2007 biological opinion was specific to the batch of permit applications received for activities covering 3 field seasons and, as clarified in the request for reinitiation memo (NMFS 2009:1) "did not broadly cover issuance of future permits under the preferred alternative of the EIS". The reinitiation request was originally made to the Endangered Species Division.

On May 15, 2009, the NMFS Director of the Office of Protected requested that the Assistant Administrator for Fisheries approve delegation of authority to the Alaska Region for Section 7 Signature for Re-Initiation of Section 7 Consultation on the PEIS for Research on Steller Sea lions and Northern Fur Seals. This delegation was signed by the Assistant Administrator on 15 May 2009 in a memorandum to the Regional Administrator, AKR.

2. DESCRIPTION OF THE PROPOSED ACTION

As described in their re-initiation memo of February 26, 2007, NMFS Permits Division, under the authority of the MMPA and the ESA, proposes to fully implement the preferred alternative of the 2007 Final Steller Sea Lion and Northern Fur Seal Research Programmatic Environmental Impact Statement (FPEIS) by issuing new permits that are valid up to the five year limit under existing regulations for marine mammal research. The Research Permits program, as described in the Preferred Alternative, would apply to permit applications currently submitted to the Permits division and to any subsequent permit applications.

Our understanding of the proposed action relies primarily on information provided by the Permits Division in four documents and in applicable sections of federal law and regulation (see below). The four documents are as follows:

- NMFS' 2007 Final Steller Sea Lion and Northern Fur Seal Research Programmatic Environmental Impact Statement (FPEIS) (NMFS 2007) (available at http://www.nmfs.noaa.gov/pr/permits/eis/steller.htm)
- NMFS' June 18, 2007 Record of Decision for the Steller Sea Lion and Northern Fur Seal Research Final Programmatic Environmental Impact Statement
- Summary Document Steller Sea Lion and Northern Fur Sea Research Final Programmatic Environmental Impact Statement" (Summary Document), dated January 2009 (provided as Appendix B of this Opinion)
- National Marine Fisheries Service Policy and Guidance for Implementation of the Steller Sea Lion and Northern Fur Seal Research Permits and Grants Programs under the Preferred Alternative of the 2007 Final Programmatic EIS (Policy and Guidance Document) (NMFS 2008) (including Appendices)(available at http://www.nmfs.noaa.gov/pr/pdfs/permits/ssl_eis_policy.pdf)

The FPEIS most fully describes the proposed action. The Record of Decision to select the Preferred Alternative from this FPEIS as its preferred strategy for the issuance of grants and permits for scientific research on Steller sea lions (SSL) and northern fur seals (NFS) lays out the agency's rationale in its choice of the alternative. The Summary Document summarizes new information that has become available since the PEIS was published in June 2007. The Policy and Guidance Document establishes the National Marine Fisheries Service's (NMFS) policy for implementation of the preferred alternative and the recommendations in Chapter 5 of in the Steller Sea Lion and Northern Fur Seal Research Final Programmatic Environmental Impact Statement (PEIS) (NMFS 2007). This document also provides guidance for issuance of permits for research on Steller sea lions (*Eumetopias jubatus*) and northern fur seals (*Callorhinus ursinus*).

2.1 Objectives of the Proposed Action

The NMFS June 18, 2007 ROD stated that:

> "The purpose of the proposed action is to disburse federal funds and issue permits for scientific research on SSLs and NFSs, consistent with applicable federal laws."

The ROD further stated that:

> The need for NMFS' grant program for research on SSL and NFS is related to its obligations to administer directed grants from its operational budget and "pass through" grants detailed in the federal budget. These grants are administered through the NMFS Alaska Regional Office.
>
> The need for issuance of permits relates to the "take" prohibitions of the MMPA and ESA. The ESA and the MMPA prohibit ''takes'' of threatened and endangered species, and of marine mammals, respectively, with a few exceptions. Permits for bona fide scientific research are one such exception. A scientific research permit allows an exemption to the "take" prohibition for research activities that may result in harassment, harm, pursuit, capture, and mortality of SSL and NFS. Many scientific research activities require approaching or capturing animals and may result in harassment or other prohibited "takes." As such, most research activities on these species require permits.

The ROD clarified that:

> "The purpose of conducting research on SSLs and NFSs, as stated in the SSL Recovery Plan and NFS Conservation Plan is to promote the recovery of the species populations to levels appropriate to justify removal from Endangered Species Act (ESA) listings (in the case of SSL) and to delineate reasonable actions to protect the depleted species (in the case of NFS) under the Marine Mammal Protection Act (MMPA). NMFS is the federal agency responsible for management, conservation, and protection of these species. NMFS facilitates research on SSL and NFS by awarding grants and issuing permits. This research may yield information that can be used by NMFS to develop more informed and effective management actions to promote recovery and conservation of SSL and NFS.

Section 1.2.2 of the FPEIS provided more specificity:

> "The need for research is rooted in fundamental questions related to understanding the biology and ecology of SSLs and NFSs, including population trends, reproductive mortality rates, foraging behavior, and energetics, as well as other factors that may be limiting the populations, such as habitat loss or degradation, predation, parasitism, and disease. The need for the proposed action stems from the responsibility of NMFS to implement the ESA and MMPA for species under its jurisdiction. For SSLs and NFSs, the need is to facilitate research to: (1) promote recovery; (2) identify factors limiting the population; (3) identify reasonable actions to minimize impacts of human-induced activities; and (4) implement conservation and management measures."

The aforementioned statements were reiterated by NMFS in the 2007 Biological Opinion on this same action. Hence, NMFS has explicitly acknowledged that at least part of the result of the action under consultation (that result being the undertaking of research on Steller sea lions) is an action permitted to promote the recovery of that same species. This understanding of the need for research to promote the recovery of a species is informed not only by the 2008 Recovery Plan for Steller Sea Lions but also from language in the ESA itself. It is clear that the ESA views research as an integral element in conservation of a listed species. Section 3(3) of the ESA states (bold font not in original):

"The term "conserve", "conserving", and "conservation" mean to use and the use of all methods and procedures which are necessary to bring an endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary. **Such methods and procedures include**, but are not limited to, all activities associated with scientific resources management such as **research**,…"

Thus, part of the result of the action being consulted on is an integral part of what is envisioned in the ESA as "conservation". It is important to understand that because of this, this action is fundamentally different than most other actions on which the Service consults. Part of the objective of this action, unlike most actions which have no purpose linked to species recovery, is to implement a program needed to permit actions (research activities) that are needed for the conservation of the two listed Steller sea lion populations.

2.2 Legal Framework for Issuing Permits

The legal framework under which NMFS can issue permits for the taking of marine mammal species during research has not changed since the consultation on this action in 2007.

Section 1.1 of the FPEIS specifies that:

"Permits are granted provided the proposed research activities are consistent with the requirements of the ESA, MMPA and the criteria in NMFS implementing regulations (50 Code of Federal Regulations [CFR] parts 216, 222, 223, and 224).

The 2007 Biological Opinion specified that permits to "take" marine mammal species that are not listed as threatened or endangered under the ESA are issued by NMFS pursuant to the MMPA and NMFS' implementing regulations at 50 CFR 216.31-41. Permits to "take" marine mammal species that are listed as threatened or endangered under the ESA are issued by NMFS pursuant to the ESA, the MMPA, and NMFS' implementing regulations at 50 CFR 222.301-309 and 50 CFR 216.31-41. The Permits Division applies the statutory and regulatory standards of the MMPA and the ESA to determine if a permit can be issued.

As noted in the ROD, the legal and regulatory framework for NMFS' responsibilities regarding marine mammals is described in Section 1.7 of the PEIS. The implementation of the Preferred Alternative must meet research and management needs within the scope of NMFS' legal limits and responsibilities. Key points from Section 1.7 of the PEIS include the following:

- NMFS' proposed act of issuing permits and awarding grants for Steller sea lion and northern fur seal research activities is subject to a number of federal laws, including the National Environmental Policy Act of 1969 (NEPA), the National Oceanic and Atmospheric Administration Administrative Order 216-6 (this describes NOAA's requirements, procedures, ,and policies for complying with NEPA and its implementing regulations), the Executive Order 12898: Environmental Justice, the Executive Order 13175: Consultation and Coordination with Indian Tribal Governments, the MMPA, and the ESA.
- Section 1.7.3 of the FPEIS lays out the requirements related to this action under the ESA as follows:
    - "The requirements for award of funds and issuance of permits to allow research on SSLs are described in Sections 2, 7, and 10 of the ESA. Section 7 also stipulates requirements for federal actions that may indirectly affect ESA-listed species, including issuance of permits under the MMPA that are likely to adversely affect ESA-listed species.
    - The purposes of the ESA, as stated in Section 2, are to provide a means whereby the ecosystems upon which threatened and endangered species depend may be conserved[1], to provide a program for the conservation of such threatened and endangered species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in Section 2(a) of the ESA.
    - Section 7(a)(2) of the ESA, as amended (ESA; 16 U.S.C. 1531 *et seq.*), requires each federal agency to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of critical habitat of such species. According to Section 7 of the ESA, NMFS must ensure that any action authorized (such as permits), funded, or carried out, is not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of critical habitat.
    - Section 10(a)(1)(A) of the ESA specifically states that the Secretary of Commerce (Secretary) may issue permits for otherwise prohibited acts for scientific purposes or to enhance the propagation or survival of the affected species. Section 10(d) of the ESA goes on to state that NMFS may grant exceptions under Subsection 10(a)(1)(A) only if the agency finds and publishes these findings in the FR that: (1) such exceptions were applied for in good faith; (2) if granted and exercised will not operate to the disadvantage of such endangered species; and (3) will be consistent with the purposes and policies set forth in Section 2 of the ESA.

The FPEIS notes that Section 4(f) of the ESA directs the responsible agency to develop and implement a Recovery Plan for the conservation and survival of the species. The FPEIS

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[1] The ESA defines "conserve" and "conservation" as "...to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to [the ESA] are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping, and transplantation, and, in the extraordinary case where population pressures within a given ecosystem cannot be otherwise relieved, may include regulated taking."

summarized that the general research needs and objectives identified in the original Recovery Plan for SSLs included research to: identify habitat requirements and areas of special biological significance; identify management stocks; monitor status and trends of sea lion abundance and distribution; monitor health, condition, and vital parameters; assess and minimize causes of mortality; and investigate feeding ecology and factors affecting energetic status (NMFS 1992a). The Final 2008 Recovery Plan for Steller Sea Lions (NMFS 2008) identified needed Recovery Actions and organized these into a Recovery Action Outline (NMFS 2008:V-25 – V-29), explained the need for these actions in a Recovery Action Narrative (NMFS 2008: V-30-V-59) and prioritized these actions in a Recovery Action Implementation Schedule (V-60-V68). A large percentage of these Recovery actions have a research focus or link.

The basic policy of the MMPA is that certain species and population stocks of marine mammals are, or may be, in danger of extinction or depletion as a result of man's activities, and such species and populations should not be permitted to diminish beyond the point at which they cease to be a significant functioning element of the ecosystem of which they are a part.

Section 1.7.4 of the FPEIS summarized that requirements related to research permitting under the MMPA as specified in Section 104 of that act:

"Section 104(c)(3)(A) of the MMPA states that the Secretary may issue a permit for scientific research purposes to an applicant who submits with the permit application information indicating that the taking is required to further a bona fide scientific purpose. Section 104(c)(4)(A) states that a permit may be issued for enhancing the survival or recovery of a species or stock only with respect to a species or stock for which the Secretary, after consultation with the MMC and after notice and opportunity for public comment, has first determined that:

1. Taking or importation is likely to contribute significantly to maintaining or increasing distribution or numbers necessary to ensure the survival or recovery of the species or stock; and
2. Taking or importation is consistent (I) with any conservation plan adopted by the Secretary under Section 115(b) of this title or any recovery plan developed under Section 4(f) of the ESA for the species or stock, or (II) if there is no conservation or recovery plan in place, with the Secretary's evaluation of actions required to enhance the survival or recovery of the species or stock in light of the factors that would be addressed in a conservation plan or a recovery plan.

This section of the FPEIS further summarizes that:

"Both the MMPA and ESA stipulate that no provision of the statute shall take precedence over any more restrictive conflicting provision of another statute. Whereas the MMPA allows for taking of marine mammals for research that is *likely to contribute to the basic knowledge of marine mammal biology or ecology in general*, the ESA only allows for issuance of permits to conduct research that is *likely to further the conservation of the affected species*. Under the ESA "conserve" is effectively synonymous with recover since the definition of conserve indicates an ultimate goal of bringing a species to the point where listing under the ESA is no longer necessary for its continued existence. Thus, the objective of funding and issuing permits for NFS and SSL research is to allow the conduct of bona fide scientific research that will be likely to contribute to recovery of those species (NMFS 2005b)."

The ROD acknowledges that:

"There is considerable flexibility under the MMPA, ESA, and NMFS regulations regarding the types of research objectives and procedures that can be permitted. If an applicant submits information demonstrating that a requested activity is consistent with the provisions of the MMPA, ESA, and permit regulations, and NMFS determines that issuance of the permit would not violate any other environmental laws, researchers can request and receive authorization for a wide variety of studies and protocols. The MMPA and ESA give NMFS authority to place such terms and conditions in research permits as are deemed appropriate. These conditions are typically specific mitigation measures that are required to minimize risk of adverse effects."

It is clear that the NMFS Permits division does have broad discretion regarding terms and conditions required in permits.

One key component of the proposed action exemplifies this discretion. In addition to the applicable statutory and regulatory requirements of permit issuance, the Permits Division is proposing to limit the total amount of incidental mortality resulting from their action to 15 percent of the Potential Biological Removal (PBR) for each stock or Distinct Population Segment.

This discretion can affect not only whether a researcher gets needed permits from NMFS but also if it can spend funds authorized by NMFS. Section 2.3 of the FPEIS clarifies this point:

"NMFS has flexibility in specifying the procedural requirements of grantees that are necessary to ensure sufficient oversight and exchange of information. The Grants Program can release funding for a program, but the grantee must send the grant manager proof that the needed permits have been obtained before spending any funds on those activities. In addition, the Grants Program Office defers to NMFS Permits Division, Office of Protected Resources (F/PR1) to establish any mitigation measures required as a condition under the authorized permit."

MMPA Permit Issuance.--Any permit issued under section 104 of the MMPA for the taking of a marine mammal, at a minimum, must specify:

A. The number and kind of animals which are authorized to be taken or imported,
B. The location and manner (which manner must be determined by the Secretary to be humane) in which they may be taken, or from which they may be imported,
C. The period during which the permit is valid, and
D. Any other terms or conditions which the Secretary deems appropriate.

Before any scientific research permit or permit issued for enhancing the survival or recovery of a species can be issued to allow takes of marine mammals protected by the MMPA, an applicant must demonstrate that the following criteria, listed under 50 CFR 216.34(a), are met:

1. The proposed activity is humane and does not present any unnecessary risks to the health and welfare of marine mammals. "Humane" is defined in the MMPA as that method of taking involving the least possible degree of pain and suffering practicable to the mammal involved.
2. The proposed activity, if it involves endangered or threatened marine mammals, will be conducted consistent with the purposes and policies set forth in section 2 of the ESA;
3. The proposed activity by itself, or in combination with other activities, will not likely have a significant adverse impact on the species or stock.
4. Whether the applicant's expertise, facilities, and resources are adequate to accomplish successfully the objectives and activities stated in the application.
5. If a live animal will be held captive or transported, the applicant's qualifications, facilities, and resources are adequate for the proper care and maintenance of the marine mammal.
6. Any requested import or export will not likely result in the taking of marine mammals or marine mammal parts, beyond those authorized by the permit.

The activity must also be consistent with all restrictions set forth at 50 CFR 216.41, 42, and 43. The specific issuance criteria for permits for scientific research and enhancement are found at 50 CFR 216.41(b). Accordingly, for the Office Director to issue a scientific research or enhancement permit, the applicant must also demonstrate that:

1. The proposed activity must further a bona fide scientific or enhancement purpose. The MMPA defines bona fide research as scientific research the results of which (a) likely would be accepted for publication in a refereed scientific journal, (b) are likely to contribute to the basic knowledge of marine mammal biology or ecology; or (c) are likely to identify, evaluate or resolve conservation problems.
2. If the lethal taking of marine mammals is proposed:
    - ii. Non-lethal methods for conducting the research are not feasible; and
    - iii. For depleted, endangered, or threatened species, the results will directly benefit that species or stock or will fulfill a critically important research need.
3. Any permanent removal of a marine mammal from the wild is consistent with quota established by the Office Director.
4. The proposed research will not likely have significant adverse effects on any other component of the marine ecosystem of which the affected species or stock is a part.
5. For species or stocks designated or proposed to be designated as depleted, or listed or proposed to be listed as endangered or threatened:
    - i. The proposed research cannot be accomplished using a species or stock that is not designated or proposed to be designated as depleted, or listed or proposed to be listed as threatened or endangered;
    - ii. the proposed research, by itself or in combination with other activities will not likely have a long-term direct or indirect adverse impact on the species or stock;
    - iii. the proposed research will either:
        - A. Contribute to fulfilling a research need or objective identified in a species recovery or conservation plan, or if there is no conservation or recovery plan in place, a research need or objective identified by the Office Director in stock assessments;

B. Contribute significantly to understanding the basic biology or ecology of the species or stock, or to identifying, evaluating, or resolving conservation problems for the species or stock; or

C. Contribute significantly to fulfilling a critically important research need.

6. For proposed enhancement activities:

    i. Only living marine mammals and marine mammal parts necessary for enhancement of the survival, recovery, or propagation of the affected species or stock may be taken.

    ii. The activity will likely contribute significantly to maintain or increasing distribution or abundance, enhancing health or welfare of the species or stock, or ensuring the survival or recovery of the affected species or stock in the wild;

    iii. The activity is consistent with:

        A. An approved conservation plan developed under section 115(b) of the MMPA or recovery plan developed under section 4(f) of the ESA for the species or stock; or

        B. If there is no conservation or recovery plan, with the Office Director's evaluation for the actions required to enhance the survival or recovery of the species or stock in light of the factors that would be addressed in a conservation or recovery plan.

    iv. An enhancement permit may authorize the captive maintenance of a marine mammal from a threatened, endangered, or depleted species or stock only if the Office Director determines that:

        A. The proposed captive maintenance will likely contribute directly to the survival or recovery of the species or stock by maintaining a viable gene pool, increasing productivity, providing necessary biological information, or establishing animal reserves required to support directly these objectives; and

        B. The expected benefit to the species or stock outweighs the expected benefits of alternatives that do not require removal of marine mammals from the wild.

In determining whether to issue a permit for scientific purposes or to enhance the propagation or survival of an endangered marine mammal, in addition to the requirements of the MMPA, NMFS shall specifically consider the following (50 CFR 222.308(c)):

1. Whether the permit would further a bona fide and necessary or desirable scientific purpose or enhance the propagation or survival of the endangered species, taking into account the benefits anticipated to be derived on behalf of the endangered species;
2. The status of the population of the species and the direct and indirect effects of the proposed action on the population;
3. If a live animal is to be taken, transported, or held in captivity, the applicant's qualifications for the proper care and maintenance of the species and the adequacy of the applicant's facilities;
4. Whether alternative non-endangered species or population stocks can and should be used;
5. Whether the animal was born in captivity or was (or will be) taken from the wild;

6. How the applicant's needs, program, and facilities compare and relate to proposed and ongoing projects and programs;
7. Whether the expertise, facilities, or other resources available to the applicant appear adequate to successfully accomplish the objectives stated in the application; and
8. Opinions or views of scientists or other persons or organizations knowledgeable about the species which is the subject of the application or of other matters germane to the application.

Under the ESA, permits exempting the prohibitions of "take" under section 9 may be granted only if NMFS finds that:
1. The permit was applied for in good faith;
2. The permit, if granted and exercised, will not operate to the disadvantage of the endangered species, and
3. Will be consistent with the purposes and policies set forth in section 2 of the ESA.

Finally, NMFS must ensure that any action authorized, funded, or carried out on Northern fur seals and Steller sea lions is not likely to jeopardize the continued existence of any endangered species or threatened species, or result in the destruction or adverse modification of critical habitat. This is done through section 7 consultation, as has previously occurred on this action that is the subject of this Opinion. NMFS has the authority to condition any and all final permits to ensure they meet the minimal requirements of the MMPA, ESA, and the implementing regulations. Monitoring and reporting is also an important and required condition of the final permit whether authorized under the MMPA or the ESA.

Description of the Preferred Alternative (Alternative 4) of the FPEIS: The Proposed Action of this Consultation

Role of the Policy and Guidance Document.--As stated above, the proposed action that is the subject of the current consultation is the full implementation of the Preferred Alternative that is well described in Section 2 of the FPEIS. However, the 2007 Biological Opinion stated that NMFS would develop the Policy and Guidance Document following the issuance of the ROD related to the selection of that alternative because:

"After conducting a critical examination of the Steller sea lion and Northern fur seal research program, the decision-making process used to authorize research permits, and the general classes of activities the program would authorize, NMFS determined that the program would benefit from a stronger, clearly articulated decision framework that promotes a reasoned way to balance competing interests and competing risks to ensure that research activities authorized under the program would not permit an exemption to the protective restrictions imposed by the Marine Mammal Protection Act and the Endangered Species Act for a particular study or investigation except when a particular study or investigation would be expected to contribute to the conservation and recovery of the species."

According to the 2007 Biological Opinion, the Policy and Guidance Document is intended to improve the implementation of the Preferred Alternative. That Opinion stated that:

“NMFS will adopt policy and guidance to improve the implementation of their Steller sea lion and Northern fur seal research program that would result in: a) minimizing intrusive handling and sampling of protected species except when a particular study or investigation would be expected to contribute to the conservation and recovery of the species, b) greater rigor in the overall decision to authorize (or not) research activities, and c) a strategy for reviewing and improving program performance, and ensuring program objectives are met.”

The Policy and Guidance Document also stated that:

> “The purpose of establishing such policies and guidance is to promote consistent compliance with the PEIS and the National Environmental Policy Act (NEPA) for
>
> • reviewing permit applications and reports
> • coordinating research
> • monitoring effects of research
> • monitoring effectiveness of research (in contributing to purpose and need in PEIS)

The Policy and Guidance Document clarifies that it is to be used by permit analysts and decision makers in OPR when they are reviewing applications for permits for research on Steller sea lions and northern fur seals.

Thus, in our evaluation of this action, we assume that the implementation of how the Preferred Alternative, as described in the FPEIS, is clarified and refined in the Policy and Guidance Document in ways intended to accomplish the goals outlined above.

Section 3 of the Policy and Guidance Document (NMFS 2009a:6) (bold font not in original) clarifies:

“…policies NMFS will follow for review of research permit applications, coordination of research, monitoring effects of research, and monitoring effectiveness of the research permits.” It also “…includes specific guidance for implementing these policies. **NMFS will adhere to this policy and guidance for all permit decisions for which this document is applicable**, as outlined in Section 1.1.”

As this Policy and guidance document is provided in Appendix C, we do not repeat other details.

Relationship to Recovery and Conservation Plans.--Section 2.1.2 of the FPEIS describes the relationship of the alternatives to the Recovery and Conservation Plans. It summarized that

- The information needs and, in some cases, specific research activities that NMFS determines are essential to the conservation of a species are outlined in recovery and conservation plans.
- The purpose and need for future research on SSLs and NFSs is based on the purposes and policies of the ESA and the MMPA as they relate to conservation and recovery of these protected species

- In general, research permits for takes of any ESA-listed species must be justified by the likelihood of contributing to the species' recovery.

- Permits for takes of marine mammals must only be issued for research reasonably likely to achieve the objectives of the MMPA.

The FPEIS stated: "Through regulations, NMFS requires that applicants for permits for research on marine mammals listed as depleted, threatened, or endangered demonstrate how the results of their proposed research would directly benefit that species or would fulfill a critically important research need. For those species which have recovery or conservation plans, such as SSLs and NFSs, applicants can most easily satisfy this requirement by demonstrating how the proposed research would contribute to fulfilling a research need or recovery objective identified in the species recovery or conservation plan."

The ROD gave the following "Major Management Reasons" that were used to select the Preferred Alternative:

"Alternative 4 includes all research activities needed to address all information objectives identified for both species of concern. This alternative would include the same types of research as described in the status quo alternative, but would also allow for activities that have not been authorized under the status quo, including new permits and permit amendments that were pending as of January 2006. However, it could also include some types of techniques and activities that have not been previously requested or authorized, including intentional lethal take. Research conducted under Alternative 4 could provide a major amount of information to support the management and conservation objectives listed in the Recovery and Conservation Plans for each species which was selected as the Preferred Alternative for that reason."

The ROD goes on to discuss Alternative 4 - The Preferred Alternative:

"This alternative would include not only those specific activities currently or previously permitted but any additional research activities or methods that are needed to implement the SSL Recovery Plan and the NFS Conservation Plan. Research activities related to priorities listed in the Draft SSL Recovery Plan have been used by past and current research programs under the status quo permits. However, some of the research questions may require use of techniques or protocols that have not previously been requested or permitted on SSLs and NFSs. As such, they may involve unique or uncertain risks to the animals. Under Alternative 4, NMFS would consider proposals for research that posed a higher, or unknown, risk of injury to individual animals, including intentional mortality of animals or other specified individuals, if the permit applicant could demonstrate that the research would provide significant data relevant to conservation of the species. Permit issuance criteria under the MMPA and ESA would still prohibit research from putting the species at a disadvantage or in jeopardy. Under Alternative 4 NMFS could authorize serious injury takes up to 15% PBR, a level greater than that for the status quo (Alternative 3) but still considered minor on the population level. Specifically, the % increase in time to recovery for the case where 35 animals were killed annually incidental to research (15% of PBR, observed and cryptic mortality) is 5.8%, while for 70 animals a year it would be 6.6%. Perhaps more important is the contrast between no mortality incidental to research and 70 animals a year. For the former (no mortality incidental to research), the %

increase in time to recovery is 4.8%. That is, mortality related to bycatch in fisheries and Alaska Native subsistence harvests alone would be expected to increase the time to recovery by 4.8% relative to a scenario of no anthropogenic removals. Therefore, the percent increase in time to recovery due to mortality incidental to research by itself is on the order of 2 percentage points (i.e., 0.066 - 0.048). As the Preferred Alternative, this approach allows the agency to fully implement the recommendations in the species' conservation and recovery plans."

The 2007 Biological Opinion stated that: "According to the PEIS, Alternative 4 is preferred because it would lead to a better understanding of Northern fur seals and Steller sea lions, more informed management decisions, and a promising prospect of recovery (NMFS 2007a)."

While NMFS chose the Preferred Alternative assuming a higher permissible percentage of PBR limit for research-related mortality, after further review, in the Policy and Guidance Document (NMFS 2009a:8) clarified its intention to retain a more precautionary upper limit on total research-related mortality for the foreseeable future. NMFS wrote:

> "Permits issued in 2007 required researchers to collect data on the effect of research activities by requiring researchers to monitor animals post-research. While new studies aimed at evaluating research effects have not been conducted, NMML completed evaluation of data from previous field work. NMFS will continue to require researchers to collect data on the effects of research as a condition of the research permits. Until there is sufficient data or information to develop more robust mortality risk assessment method, NMFS will limit research-related mortality to the levels permitted in 2007: below 10% of potential biological removal for each stock. These mortalities will be allocated among research applicants based on the types of research activities and numbers of takes requested."

Thus, based on this wording in the Policy and Guidance Document provided to PRD as part of the re-initiation package, we assume that research-related mortality will be limited to the levels permitted in 2007: below 10% of potential biological removal for each stock.

Types of Activities that May Occur.—

Table 2.4-1 (reproduced from the FPEIS) specifies the kinds of research that could occur under the Preferred Alternative and that require a research permit. This table does not list intentional lethal take which would also require a permit.

Table 2.4-1 Research Activities Requiring Permits (reproduced from FPEIS)

Research Activities	
That Result in No Capture, Handling or Collection of Tissue	**That Require Capture, Handling or Collection of Tissue**
• Aerial, vessel, and ground surveys – conducted to count animals, resight animals that have been tagged and branded, and to document behavioral observations. • Scat collection – occurs on rookeries and haulouts and is used to estimate recent prey consumed. • Remote monitoring – includes photographs and video images from remote stations located to document seasonal movements, changes in population structure, number of entangled or injured animals, and record presence of tagged or branded animals. • Receipt of tissue samples from Alaska Natives who have taken the animal legally for subsistence harvest; used to measure chemical/physiological parameters. • Receipt of tissue samples from animals found dead from other causes; used to measure chemical/physiological parameters.	• Collection of morphometric measurements – includes external measurements of an animal. • Collection of tissue samples – including skin, muscle, blubber, vibrissae, teeth, blood, and fluids. • Analysis of body composition – through injection of stable isotopes, ultrasound, bioelectric impedance analysis, chromic oxide and Co-EDTA, and portable metabolic chamber. • Enema or stomach intubation – used to collect and analyze stomach/digestive tract contents. • Permanent or temporary marking of animals – includes plastic tags secured on the foreflipper, hot-branding, and freeze-branding, which are used to monitor animals, to facilitate recapture of sampled animals, and to determine population's vital rates. • Attachment of scientific instruments – used to collect information on movement patterns and foraging behavior. • Insertion/implantation of instruments – used to monitor pressure, motion, light levels, temperature, and conductivity. • Temporary captivity – temporary removal from wild, transportation, and studies of the animal's nutrition and physiology.

The following description of activities that may occur under the preferred alternative is taken or modified from the description provided by the Permits Division in Section 2.3 of the FPEIS. It is supplemented, if necessary with additional information gained from reports, applications, or other sources.

Aerial Surveys: The purpose of aerial surveys is to obtain photographs from which to count the number of animals present on a rookery (breeding and pupping sites) or haulout (resting sites). Annual counts from many areas and selected "trend sites" are used to estimate population abundance, pup production, and trends. Currently, aerial surveys fly over rookeries and haulout sites at slow air speeds (100-150 knots), low altitudes (150-200 meters [m]), and close to shore (500 m), to take color photographs (35 millimeter [mm] slides) and videos (Calkins and Pitcher 1982). Since 2002, some researchers have used medium format color photogrammetry instead of 35 mm slides, which allowed them to count pups and improve counts of non-pups (Fritz and Stinchcomb 2005). The surveys typically include a single pass over each site, with additional passes made only when the photographers have reason to believe they may have missed part of the site. Replicate surveys on separate days are occasionally conducted to develop an estimate of the survey variance. Such estimates require multiple surveys at individual sites.

Mitigation used to minimize disturbance of the animals includes provisions to approach rookeries and haulouts from offshore in straight line flight and to avoid banking maneuvers.

Vessel Surveys: Marine vessels are used to approach haulouts and rookeries to count pups, resight branded and tagged animals, and to obtain behavioral observations. Research vessels may remain within close proximity to a rookery or haulout for up to two to three days at a time.

Ground Counts: Researchers go ashore during June and July to count young pups because aerial surveys are inadequate to reliably detect pups in some locations. Whenever possible, pups are counted from overlooks or other vantage points to minimize disturbance of rookeries. However, when these methods are unsuitable for accurate counts, or when tissue sampling or marking of animals is also part of the research protocol, adult and juvenile animals are intentionally driven or "spooked" from the rookery into the water in order to facilitate counting pups. The median pupping date in Alaska is June 12; therefore, the majority of pups on a rookery would be greater than 2 weeks old, depending on the timing of parturition. After all or the majority of non-pups have retreated, two or more biologists walk across the rookery, making independent counts of live and dead pups on the beach and in the water. Researchers typically occupy the rookery for approximately two hours for counting, except when a number of pups are captured for weighing, measuring, and collection of tissue samples. In these instances, time on the rookery is determined by the processing time associated with various sampling protocols. After researchers leave, displaced breeding males often need to fight other males to reestablish their territories, resulting in additional chance of injury to males and others nearby. The separation risk of mothers and pups in these situations has not been well studied but may result in mothers failing to locate their own pups, aggression toward pups from other females, or aggression between females who may fight over pups if confused about which pup is theirs. In 2002, some researchers began using a new aerial survey photographic technique, medium format color photogrammetry, which allowed counts of pups as well as non-pups

(Fritz and Stinchcomb 2005). This technique provided accurate results compared to traditional drive-counts with essentially no disturbance of the rookery (Snyder *et al*. 2001).

Scat Collection: Scat (fecal) collection provides a mechanism for broad estimates of the recent preyconsumed, with some limitations and biases (Bigg and Fawcett 1985, Antonelis *et al.* 1987, Harvey 1989). Personnel go ashore on rookeries and haulouts to collect scat samples for dietary studies, which can result in harassment and displacement of SSLs if they are present, but does not require capture. Scat samples are also analyzed for levels of hormones associated with stress and reproduction. Scat collection is typically conducted during ground counts or other research activities on rookeries and haulouts, such that little or no additional harassment results, and may also occur when animals are not present.

Behavioral and Demographic Observations and Remote Monitoring: Field teams are stationed at select locations to conduct counts of SSLs and NFSs by sex/age class, conduct studies of attendance patterns of branded, tagged, and naturally-marked animals, record the presence of tagged and branded animals, and record observations of entangled or injured SSLs and NFSs and the presence of other marine mammals and boat or air traffic. Remote monitoring stations are set up on selected islands to collect similar data on seasonal movements and changes in population structure of SSLs and NFSs using still photographs, video images, very high frequency (VHF) telemetry signals, and sonic transmitters. Observations are made from cliffs or other vantage points above rookeries and typically do not result in any takes. Establishing and servicing remote monitoring stations may result in harassment of some animals.

Capture and Restraint

It is usually necessary to restrain an animal in order to collect tissue samples, collect morphometric measurements, mark animals, or attach scientific instruments. Conducting physiological examinations, attaching flipper tags, or applying hot-brands can only be performed on animals that are physically or chemically restrained. There are a variety of available capture and restraint methods, depending on the size of the animal and the time of year for capture. After capture, several types of procedures are generally conducted on the animal.

On the rookery, very young pups are caught and picked up by researchers by hand or in a hoop net and may be restrained by gas anesthesia with isoflurane through a mask over the nose. Capture of older/larger animals usually requires the use of a net, trap, or an injectable immobilizing agent such as Telazol (tiletamine-zolazepam) administered remotely by dart. Animals in the water are captured using a hoop net, rope lasso/noose, or floating platform trap. Older animals may be restrained with a “fabric restraining wrap” and use of isoflurane or Valium (diazepam) for sedation. Determining the proper dose of immobilizing agent and anesthesia is dependent on a fairly accurate assessment of the animal’s weight and condition; miscalculation of an animal’s weight can lead to an overdose, which can have lethal consequences (Fowler 1986b).

Mitigation measures in permits include the condition that these procedures be performed or directly supervised by qualified personnel so that the operations go as quickly and efficiently as possible and recommend that an experienced marine mammal veterinarian be present for all use of anesthesia and sedatives. Other provisions describe "best practices" for equipment that should be used, sterile techniques, parts of the body best suited for different procedures, and how to position, monitor, and treat anesthetized animals with an emphasis on animal health and safety over experimental sampling. Special precautions are required for work with lactating females and pups. To the maximum extent practical without causing disturbance of the rookery/haulout, researchers are required to conduct post-handling, monitoring of captured or sampled animals for signs of acute stress or injury. Researchers are also required to monitor rookeries/haulouts after disturbance to determine if any animals have been injured or pups abandoned.

Morphometric/Physiological Measurements and Tissue Sampling: Most animals captured for sampling or marking are weighed and measured (e.g., standard length, girth). In addition to these morphometric measurements, **blood samples** are collected from pups and juveniles of both sexes by venipuncture for a variety of analyses ranging from basic health assessment to estimating blood volume.

Muscle biopsies are obtained through small incisions with canula needles and can be used to analyze myoglobin content and fiber type. Evans blue dye is an injectable dye that is used to measure blood volume through a series of blood samples over 30 minutes. The technique is used in combination with muscle biopsies to estimate aerobic dive capacity, which could provide a better understanding of when young SSLs and NFSs become physiologically able to access various prey resources. Determining how aerobic dive capacity changes with developmental stage from pup to juvenile is also used in interpreting foraging behavior derived from telemetry data.

Skin biopsies are obtained by punching tissue from the webbing of the hind flipper, and are used for genetic analyses to identify biologically discrete (management) stocks, delineate home ranges, and evaluate site fidelity and the degree of population interchange. Blubber samples are taken through small incisions with a biopsy punch or a remotely-fired dart and are used to compliment studies of diet, feeding ecology (via analysis of fatty acids and stable isotopes), and contaminants. Wounds from tissue sampling procedures are usually left open (no sutures or other methods will be used to close the wounds) to allow any abscesses that may form from infection to drain.

Fecal and fluid samples are collected from dermal lesions, eyes, rectum, and vaginal areas with sterile culture swabs and used for determination of parasites, disease, and hormone concentrations.

One pre-molar tooth is extracted under general anesthesia in order to estimate the age of the animal by sectioning the tooth in a laboratory and counting incremental growth layers. An animal's size at a given age is one of the most useful measures of body condition and is important in measurement of weaning status.

Vibrissae, hair, and nails are clipped for analysis of stable isotopes to determine the trophic level at which an animal has been feeding over time and potentially for genetic analyses.

Enemas are used to collect the contents of the digestive tract for analyses of an animal's diet. The process involves insertion of a tube into the rectum of an anesthetized animal followed by flushing with several liters of water. Researchers may also use stomach intubation on anesthetized animals as an alternative to, or in conjunction with, enemas for collecting diet samples. Stomach intubation may also be used to test for the presence of milk in pups and to obtain a milk sample.

Bioelectric Impedance Analysis (BIA) is a method for measuring body composition by measuring the conductivity across electrodes inserted subcutaneously (under the skin). The procedure involves inserting four needles, two just behind the skull and two near the tail, to measure the rate of a small current between them.

Portable ultrasound equipment can be used to obtain two-dimensional visualization of many internal organs and to estimate blubber thickness. The ultrasound equipment is used outside of the body or inserted vaginally or rectally. Animals must be either physically or chemically restrained to accomplish this procedure. Portable metabolic chambers have also been used to measure oxygen consumption and other physiological variables that relate to energy budget calculations.

Physiology, metabolism and energetics.--Measurements of energy expenditure, food consumption, water (and milk) influx, total body water, and body composition can be obtained through techniques using injection of stable isotopes such as deuterium labeled water. An initial blood sample must be taken to determine the animal's natural isotopic background concentration along with an accurate measurement of the animal's mass. A measured amount of isotope is administered and the animal is held or recaptured after one to three hours to allow for isotope equilibration, and a second blood sample is taken.

Diet quality.--Chromic oxide and Co-EDTA can be used as markers in studies of the digestibility of food. These substances, administered in or with food, allow quantification of the rate of passage of food through the digestive track. They also allow measurement of the relationship between food intake and digestibility of various food items. This technique requires that animals be maintained in "dry holding" for up to 48 hours to eliminate access to additional food and water during the trial while allowing for collection of urine and feces.

Permanent and Temporary Marking: Animals that are captured are routinely marked to facilitate monitoring of post-procedure animals, to avoid or facilitate recapturing animals that have already been sampled, and to determine a population's vital rates such as age-specific survival and age at first reproduction. Studies on seasonal movements, site fidelity and dispersal are also facilitated by the ability to identify individuals at a distance. Brightly colored plastic tags bearing unique alphanumeric codes may be affixed to flippers of any animal captured, including pups as young as one week old. These types of tags are affixed to the trailing edge of each foreflipper, through the loose skin near the area where the flipper meets the body, using special pliers in a process similar to ear piercing. Flipper tags are subjected to extreme physical abuse and under typical field conditions they are expected to last four to six months before being torn loose or becoming unreadable.

Hot-branding is the technique currently used to permanently mark SSLs with a unique combination of numbers and/or letters. It involves the use of steel branding irons, heated to "red-hot" (about 500 ^{o}F) in a propane forge, and applied to the shoulder of an anesthetized animal to produce burns that penetrate the entire outer layer of the skin and into the inner skin layer (i.e., 2nd degree burns). These burns are characterized by formation of blisters, swelling, and fluids seeping from the burned area. Each brand requires about one minute to complete, exclusive of preparation and anesthesia. The effects of hot-branding and freeze-branding are discussed in more detail in Sections 2.9 and 2.10 of Appendix B of NMFS 2007 and in Appendix E of this Opinion. Any captured and sampled animals of all ages may be hot-branded for future identification. The process of branding pups on rookeries usually involves driving the majority of juvenile and adult animals from the rookery, as described for ground counts previously. Branding of animals captured at sea, outside of breeding season, or otherwise away from rookeries may not result in disturbance of other animals.

External Attachment of Instruments: Various instruments such as VHF transmitters and satellite-linked time depth recorders (SLTDR) may be attached to animals for remote collection of data on movement patterns and foraging behavior. Instrument packages are usually attached to the dorsal surface, head, or flippers by gluing to the hair with a fast-drying epoxy adhesive. The duration of instrument attachment is dependent on the timing of molt because the instrument will be shed as the hair is molted. The mass, dimensions, and drag characteristics of the instruments vary with the type of instrument and should be designed so that they do not interfere with an animal's ability to forage or function.

Insertion/Implantation of Instruments: Life History Transmitters (LHX tags) are data loggers equipped with sensors to monitor pressure, motion, light levels, temperature, and conductivity. They are surgically implanted in the peritoneal cavity under general anesthesia and record data from the sensors for up to 10 years. Surgical incisions are closed using absorbable sutures and the instrument is retrieved after the animal dies.

Other types of instruments, such as stomach temperature "pills," can be inserted under sedation or anesthesia into an animal's stomach through the mouth. Sensors measure changes in pressure, impedance, and stomach temperature that are correlated to feeding events and transmit the data to implanted data loggers or externally attached satellite transmitters. When used with external dive recorders and satellite tags stomach temperature sensors can provide data about when and where geographically and in the water column prey are captured.

Transport and Temporary Captivity: The Alaska SeaLife Center (ASLC) has had permits to capture and transport SSLs to its facility in Seward, Alaska, where the animals are held for several months and used in a variety of nutritional and physiological studies before being released to the wild. While the NMFS research permit governs the capture, research conditions, and eventual release requirements, the conditions for their humane transport and care in the holding facilities are governed by the requirements of the AWA, which is administered by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service). Pursuant to the AWA, the research procedures must be reviewed and approved by the ASLC's Institutional Animal Care and Use Committee (IACUC). The experiments conducted on these "transient" SSLs involve a variety of feeding regimes, injection of various substances, and collection of various tissue samples, including blood and blubber. All animals are marked with a flipper tag or hot-brand and may have external scientific instruments attached prior to being returned to the wild. The studies conducted by the ASLC on these "transient" SSLs are intended to provide a basis for interpreting samples taken from animals in the wild with regard to nutritional and metabolic responses to different environmental variables.

Incidental Mortality: No existing permit authorizes intentional lethal takes of SSLs or NFSs. However, to acknowledge the fact that there is an inherent risk of serious injury and mortality associated with some research activities on wild animals, all permits allow for a limited number of mortalities incidental to the research. The number of incidental mortalities allowed is based on a permit holder's estimate of the potential for such mortalities. The overall total of all permitted incidental takes is considered by the Permit Office through the application review process and by evaluation of field reports submitted by permit holdrers as required by conditions attached to all issued permits.

Intentional Lethal Take: No description is given in the FPEIS as to how animals might be killed.

Take that could occur unintentionally.--Consistent with the broad definitions of "take" under the MMPA and ESA, permits issued pursuant to Section 104 of the MMPA and Section 10(a)(1)(A) of the ESA provide an exemption from the take prohibitions for any mortality resulting from the actions or presence of the researchers while conducting permit-authorized activities, as limited by the numbers specified in the permit. This exemption includes, but is not limited to: deaths of dependent pups by starvation following abandonment resulting from disturbance to a rookery or research-related death of a lactating female; adverse reactions to anesthetics or other chemical agents; infections resulting from intrusive research procedures; capture myopathy resulting from the stress of capture and handling; and serious injuries sustained in attempts to escape or evade capture or in response to stampedes, or aggressive social interactions caused by research activities.

Serious Injury and Mortality Limits Built into the Proposed Action

The proposed action has serious injury and mortality limits built into it. Based on information provided in the FPEIS, we describe first how these were established and then describe what those limits are for the proposed action (implementation of the Preferred Alternative).

The following description of how the serious injury and mortality limits are set under the Preferred Alternative is based on Section 2 of the FPEIS.

In the FEIS, NMFS (2007) acknowledged that all research activities create some risk of injury to animals. Some research activities, like tissue sampling from captured animals, may elevate stress in every animal captured. Other activities, such as aerial surveys, may affect a large proportion of the entire population (because the surveys are conducted over a large part of the range) but cause disturbance reactions in a very small proportion of the animals being surveyed.

There is variability in how a given potential factor will affect a given individual depending on characteristics of that animal (age, sex, reproductive sate, etc.), the exact actions of the researchers, season, time of day, weather, lighting, location of the research, and environmental factors such as sea conditions and weather. Some reactions may be very minor and short-term, others may cause injuries that could temporarily hamper foraging, and others may constitute serious injuries that result in death. Each research activity, therefore, has different inherent risks to the population, measured by a combination of the intensity of possible responses and the number of animals affected.

Chapter 4 of the FPEIS described the methodology and risk assessment analysis for the research efforts represented by each of the alternatives, including the Preferred Alternative. One of the metrics used to measure the possible risks of research is a calculation of potential serious injury and mortality that results from a given number of takes for different research activities. The importance of this number of potential mortalities to the species is relative to the status of the population of animals it affects. The Potential Biological Removal (PBR) was used in the PEIS as a tool by which to assess varying levels of accepted "mortality and serious injury risk" across alternatives.

PBR is defined in the MMPA as "...the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population." The MMPA defines the calculation of PBR as the product of three elements: the minimum population estimate (Nmin); half the maximum net productivity rate (0.5 R max); and a recovery factor (Fr) based on the status of the stock. Wade (1998 and 2005) described the statistical basis and underlying justification for each of these elements. PBR describes an upper limit of animals that could be removed from a population of marine mammals without causing the population to drop or remain below its optimal sustainable population (OSP). This limit is not meant to imply that if human-mortality is below PBR, a population below OSP would necessarily increase, because other resource limitations could be limiting population growth. Rather, this limit implies that for a declining population in which direct human-caused mortality is below PBR, the human-caused mortality is the cause of neither the decline nor the failure of the population to recover. The formula for PBR is therefore considered a precautionary or conservative measure of human-caused mortality that could be expected to affect a population's ability to recover from a depleted state or to remain at a sustainable level. However, the setting of acceptable limits of PBR and the evaluation of known human-caused mortality against those levels may provide a misleading sense of security about risk from human-caused mortality if known human-caused loss is a serious underestimate of the real human-caused level of mortality. PBR is based on the concept that each stock will have a natural ability to expand if it has a positive value for net production (gross reproduction minus natural mortalities). The idea is to prevent human-caused mortalities from creating a net production loss. The PBR calculation contains provisions to account for uncertainty in population estimates and protects a larger fraction of net production for depleted stocks through the Fr. The use of an Fr less than 1.0 allocates a proportion of expected net production towards population growth and compensates for uncertainties that might prevent population recovery, such as biases in the estimation of Nmin and R max, or errors in the determination of stock structure.

For endangered stocks, Fr is set at 0.1, so that 90 percent of the endangered stock's annual net production is reserved for recovery of the stock. Through a series of extensive simulation modeling, NMFS has calculated that keeping human-caused mortality at or below PBR calculated with a recovery factor of 0.1 would increase the recovery time of endangered marine mammals by no more than 10 percent (Wade 1998). For threatened and depleted stocks, Fr is set at 0.5 so that 50 percent of the stock's annual net production is reserved for recovery. However, because its population trend has been increasing for almost 20 years, Fr for the threatened eastern distinct population segment (DPS) of SSLs has been set at 0.75. For non-depleted stocks, Fr is set at 1.0 so that human-caused mortality could account for 100 percent of a stock's annual net production and still not cause a decline in the population. It is important to realize that for endangered, threatened, and depleted stocks, the use of an Fr <1.0 means that human-caused mortalities that exceed PBR would not cause the population to decline (unless human-caused mortality accounted for all of the annual net production), but could slow the rate that the population recovers. The PBR approach was tested extensively through simulation trials (Wade 1998) to evaluate robustness to variability or biased abundance estimates, mortality estimates and other parameters. These simulations demonstrated that 95% of the trials equilibrated within OSP levels when default parameters for Nmin, Rmax, and an appropriate recovery factor were used. Consequently, NMFS concluded that the PBR approach was an appropriately conservative mechanism to evaluate the effect of human-caused mortality on a stock, even for many declining populations (NMFS 1992, Barlow et al. 1995, Wade and Angliss 1997, Wade 1998, Wade 2005). Such a conclusion applied when the value for the recovery factor was 0.5. When the recovery factor value was 0.1, more than 95 percent of simulations equilibrated within OSP levels; thus, the approach is even more conservative for those stocks with the recovery factor of 0.1 (e.g., the western DPS of SSLs). Using the information from Wade (1998), human-caused mortality at a level equal to PBR of a stock with a recovery factor of 0.1 would cause the population to equilibrate within 95 percent of the abundance it would have achieved without such mortality. An equilibrium level so close to an unexploited population level indicates minimum impact to the population.

The MMPA requires NMFS to calculate PBR for each management stock of marine mammal, if possible, and to describe those calculations in its annual stock assessment reports. Based on the most recent stock assessment data (Angliss and Outlaw 2007, Carretta *et al.* 2007), PBR for the endangered western DPS of SSLs is 234 animals; and PBR for the threatened eastern DPS of SSLs is 2,000 animals.

As described in the PEIS, the levels of research activity represented in the Preferred Alternative correspond to a level of risk to individual animals. The risk for the Preferred Alternative is greater than that for the alternative which NMFS did not choose. However, the potential benefit from the research was also lower. Increased intensity of field research and more intrusive types of research pose greater risks to individuals, even if they provide useful information for conservation purposes. In order to provide a guideline for the maximum amount of risk to individuals that would be acceptable under each of the alternatives, NMFS established an upper threshold level of mortality relative to PBR. This does not mean that NMFS would be obligated to authorize takes up to these threshold levels or that a certain percentage of PBR will be allocated to research regardless of other types of mortality. These upper limits will be used only as guidelines for the permitting process.

Based on the information in the FPEIS, we assume for the purposes of this Opinion that the upper thresholds will be in place and while, based on the aforementioned language from the FPEIS, they may not allocated, we do assume the Permit Office will adopt procedures and permit limitations (conditions) to ensure these thresholds will not be exceeded.

To ensure accurate portrayal of the proposed action, the following description of the Preferred Alternative, the Proposed Action under this Consultation, is based on, and in some parts taken from, Section 2.6.4 of the FPEIS.

The proposed action, the Preferred Alternative of the FPEIS would include not only those specific activities currently or previously permitted but any additional research activities or methods that are needed to implement the 2008 SSL Recovery Plan (NMFS 2008) and the new NFS Conservation Plan (NMFS 2006b), assuming they are consistent with the MMPA, ESA, and NMFS implementing regulations. The new SSL Recovery Plan identifies 78 substantive actions needed to achieve recovery of the western DPS. All recovery actions were prioritized into three categories in the implementation schedule (NMFS 2008). Priority 1 actions are, by definition, those actions "that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future." Priority 2 actions are defined as those "that must be taken to prevent a significant decline in species population/habitat quality or some other significant impact short of extinction." Priority 3 actions are defined as "all other actions necessary to provide for full recovery of the species."

Many of the research activities related to priorities listed in the SSL Recovery Plan have been used by past and current research programs under the Status Quo permits. However, there are some research questions listed in the plan that have not received adequate attention in the past, either because they would require larger budgets than were available or because researchers elected not to attempt them because of the logistical challenges they presented. Some of these research questions may require use of techniques or protocols that have not previously been requested or permitted on SSLs and NFSs. As such, they may involve unique or uncertain risks to the animals. These new techniques or procedures would likely require additional NEPA Analysis and ESA Section 7 consultation.

Under the Preferred Alternative, NMFS would consider proposals for research that posed a higher risk of injury to individual animals, including intentional mortality of animals or other specified individuals, if the permit applicant could demonstrate that the research has a reasonable chance of providing significant data relevant to conservation of the species. Permit issuance criteria under the MMPA and ESA would still prohibit research from putting the species at a disadvantage or in jeopardy and all other issuance criteria of both the ESA and MMPA previously discussed must be met. The total amount of incidental mortality allowed under all permits and authorizations would not exceed 10 percent of PBR for each stock (western SSL: PBR is 239 – 15% is 35 animals, eastern SSL: PBR is 1,998 – 15% is = 300, eastern Pacific NF: PBR is 14,070 – 15% is =2,289, San Miguel Island NFS PBR is 219 – 15% is = 33).

Regarding the eastern DPS, the SSL Recovery Plan recommended the initiation of a status review to consider removing the eastern DPS from the ESA's List of Threatened and Endangered Wildlife. If, following the status review, the eastern DPS is delisted, then pursuant to section 4(g) of the ESA the agency is required "in cooperation with the States to monitor effectively for not less than five years the status" of the eastern DPS. Given the long-term increasing population trend and lack of significant conservation threats, the SSL Recovery Plan concludes that, if the eastern DPS is delisted, the primary recovery goal is to develop a post-delisting monitoring plan to ensure re-listing is not necessary after removal. Key components of this plan relative to research activities have not been prioritized in the SSL plan but would be likely to include population-trend monitoring, genetics research to refine population structure, monitoring terrestrial habitat threats, monitoring for unusual mortality events that may be related to contaminants or other human factors, and monitoring fishery management plans to ensure that they stay consistent with SSL requirements. These are activities that have previously been permitted and would be considered under Alternative 4.

The Draft NFS Conservation Plan identified 58 tasks needed to achieve recovery of the depleted eastern Pacific stock, as prioritized in the implementation schedule (NMFS 2006b, pp 82). The actions that contain field research components are as follows:

- monitor and manage subsistence harvest;
- identify and evaluate illegal harvests;
- conduct basic studies on fur seal feeding ecology;
- determine impact of fisheries;
- monitor male and pup abundance at Pribilof Islands;
- estimate pup survival;
- evaluate marking and resighting program;
- study vital rates;
- conduct behavioral/physiological studies;
- conduct comparative studies between Pribilof Islands animals and other islands;
- conduct oceanographic and fishery surveys in relation to essential NFS habitat; and
- reevaluate carrying capacity.

Alternative 4 represents an extensive research program that would be able to simultaneously address multiple issues over a huge geographical space. To be fully implemented, such a program would require a much larger research budget than is currently allocated to these species. It would also require greater administrative support for the Grants, Permits, and Regional Offices of NMFS in order to efficiently process the large number of projects. For the purposes of the PEIS and this opinion, it is assumed that the grants and permits processes will be essentially the same as under the Status Quo. However, if adequate funding were available to implement this expanded research program, it is likely that NMFS would adopt one or more of the measures, discussed in Chapter 5, to expedite the review process and to improve communication and coordination, not only between researchers, but between the various branches of NMFS involved in the research program, the Alaska Native communities affected by research, other federal and state agencies, and the public.

Research Activities Allowed Under the Preferred Alternative (modified from Table 2.6.1 in the 2007 FPEIS)

Research Activities	Alternative 4 – Research Program with Full Implementation of Conservation Goals
Research activities on live animals with No capture, restraint or collection of tissues	
Aerial surveys	√
Vessel surveys	√
Ground surveys	√
Scat collection	√
Remote video/photographic monitoring	√
Receipt of tissue samples from Alaska Natives that have taken the animal legally for subsistence harvest	√
Receipt of tissue samples from animals found dead from other causes	√
Research activities on live animals that requires capture, restraint or collection of tissues	
Collection of morphometric measurements	√
Collection of blood samples	√
Muscle biopsies	√
Skin biopsies	√
Blubber samples	√
Fecal and fluid samples	√
Extraction of pre-molar teeth	√

Table 2.6-1 (continued) Research Activities Allowed Under the Preferred Alternative

Research Activities	Alternative 4 Research Program with Full Implementation of Conservation Goals
Collection of vibrissae, hair, and nails	√
Enema or stomach intubation	√
Bioelectric Impedance Analysis	√
Ultrasound	√
Stable isotope injection	√
Chromic oxide and Co-EDTA	√
Temporary marking	√
Research activities on live animals that requires capture, restraint or collection of tissues	
Permanent marking	√
Attachment (external) of scientific instruments, measurements	√
Insertion/implantation (internal) of instruments	√
Temporary captivity	√
Intentional take of animals	√

Funding of research.—Under this alternative, NMFS would fund research as it has in the past using a variety of program and directed funds. In the past the Grants Program has relied upon Steller sea lion Research Initiative, comments from NMFS' scientists and constituency panels, and guidance from NMFS' Assistant Administrator to determine the projects that would receive funding. In issuing funding, the AKR Grants Office required that the grantee provide proof that they obtained the necessary permits and that the activities funded would support the core mission and goals of NMFS. Although the two offices, the Permits Division and the AKR Grants Office, work in concert with each other, permitting decisions are explicitly implemented by statute and regulation and form the foundation upon which grants can be issued. Consequently, most of this Opinion focuses on permitting Northern fur seal and Steller sea lion research.

Action Area

The action area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). In the 2007 Biological Opinion, NMFS (2007a) concluded that:

> "The action area for this consultation encompasses the land and waters where the research on Northern fur seals and Steller sea lions would be authorized by NMFS. This includes coastal and estuarine waters and limited portions landward of the entire west coast of the United States, from southern California to Alaska, and portions of the United States' Exclusive Economic Zone. The extent of the action area considered herein is defined by the research activities proposed for authorization in the thirteen permits. While the majority of research activities would focus on animals located on rookeries, haulouts, and in waters surrounding these areas, the action area would include transit routes to the study sites (e.g., boat transiting from various ports along the western seaboard). The action area extends to transit routes because water travel may result in incidental indirect effects on non-target aquatic species, such as whales. The Alaska Sea Life Center, a captive animal facility, is also included in this action area."

We have examined the differences between the limited implementation of the research program consulted on in 2007 versus the full implementation of the Preferred Alternative, as is the subject of this consultation. We conclude that the action area remains the same. There are not indirect or inter-related effects of the Full Implementation that extend this action area further. We clarify the aforementioned action area description however to detail that it includes waters, haulouts, and rookeries adjacent within the Bering Sea, the Gulf of Alaska, and other areas of the North Pacific Ocean and adjacent areas where Steller sea lion or northern fur sea research may be authorized.

Interrelated and interdependent activities

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. 50 CFR 402.02. NMFS has not identified any interrelated or interdependent actions for this biological opinion.

3. STATUS OF SPECIES AND CRITICAL HABITAT

3.1 Introduction and Background

Section 3(15) of the ESA, as amended states: "(T)he term "species" includes any subspecies of fish or wildlife or plants, and any distinct population segment of any vertebrate fish or wildlife which interbreeds when mature" (16 U.S.C. § 1532). Thus, under the ESA, distinct population segments (DPS) and subspecies are included in the definition of species and such entities are sometimes listed separately from other subspecies and/or DPSs of the same biological species.

Based on the best available information, the following listed species are found within the action area. The common and scientific names of these species, as well as the listed DPS or Evolutionarily Significant Unit (where relevant) designation of these species are given below:

- threatened Steller sea lions (*Eumetopias jubatus*), Eastern Distinct Population Segment
- (DPS)
- endangered Steller sea lions (*E. jubatus*) Western DPS
- endangered killer whales (*Orcinus orca*), Southern Resident DPS
- endangered humpback whales (*Megaptera novaeangliae*)
- endangered blue whale (Balaenoptera musculus)
- endangered bowhead whales (Balaena mysticetus)
- endangered fin whale (Balaenoptera physalus)
- endangered North Pacific right whale (Eubalaena japonica)
- endangered sei whale (Balaenoptera borealis)
- endangered sperm whale (Physeter macrocepaphalus)
- endangered beluga whale (Delphinapterus leucas), Cook Inlet DPS
- green sea turtle, loggerhead sea turtle, leatherback sea turtle, olive ridley sea turtle
- blue whales, bowhead whales, sperm whales, sei whales, humpback whales, fin whales, northern right whales, and southern resident killer whales
- Guadalupe fur seals
- threatened and endangered sockeye salmon (*Oncorhynchus nerka*) [listed by ESU]
  Ozette Lake sockeye salmon, Snake River sockeye salmon,
- threatened and endangered coho salmon (*O. kisutch*) [listed by ESU]
  Central California coast coho salmon, Lower Columbia River coho salmon, Southern Oregon and Northern California coast coho salmon
- threatened and endangered chinook salmon (*0. tshawytscha*:~ [listed by ESU]:
  California coastal Chinook salmon, Central Valley spring run Chinook salmon, Lower Columbia River Chinook salmon, Upper Columbia River spring-run Chinook salmon, Puget Sound Chinook salmon, Sacramento River winter-run Chinook salmon, Snake

River fall-run Chinook salmon, Snake River spring/summer-run Chinook salmon, Upper Willamette River Chinook salmon, Columbia River Chinook salmon

- threatened chum salmon (*0. keta*) [listed by ESU]:
  Hood Canal summer-run chum salmon
- threatened and endangered steelhead trout (0. mykiss) [listed by ESU]
  Central California coast steelhead, Puget Sound steelhead, Snake River steelhead, Upper Columbia River steelhead, Southern California steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, Upper Willamette River steelhead, Northern California steelhead, South-Central California coast steelhead, and California Central Valley steelhead

Of the species listed above, the Cook Inlet DPS of the beluga whale has been added to the list of species protected under the Endangered Species Act since the 2007 consultation on Steller Sea Lion and Northern Fur Seal Research Permitting.

There is also designated critical habitat for some of the listed species in the action area.

Critical habitat has been designated for Steller sea lions in Alaska, California, and Oregon (50 CFR 226.202). In Alaska, major rookeries and haulouts and associated air, terrestrial, and aquatic zones are listed. In California and Oregon, major rookeries and associated air, terrestrial, and aquatic zones are listed. Three special aquatic foraging areas are listed in Alaska, including Shelikof Strait, Bogoslof, and Seguam Pass. No primary constituent elements of Steller sea lion critical habitat were identified in the listing (see below for detail on this critical habitat).

Critical habitat has been designated for the North Pacific right whale in the Gulf of Alaska and Bering Sea (50 CFR 226.203). The primary constituent elements are listed as copepods and euphausiids in areas in which northern right whales are known to feed.

Critical habitat has been designated for a number of Evolutionarily Significant units of threatened and endangered Pacific salmon and anadramous trout in Washington and Oregon and includes freshwater and estuarine areas, with primary constituent elements (PCEs) or habitat. This critical habitat is described in 50 CFR Part 226.210-212) and pages 40-41 of the 2007 Biological Opinion (provided in Appendix A).

While these species could conceivably occur within the action area, NMFS's 2007 Biological Opinion concluded that:

> "Our review finds that the proposed activities would have no effect on green sturgeon, and white abalone, and may affect, but are not likely to adversely affect the following listed species and their critical habitat (where designated):
>
> California coastal Chinook salmon, Central Valley spring run Chinook salmon, Lower Columbia River Chinook salmon, Upper Columbia River spring-run Chinook salmon, Puget Sound Chinook salmon, Sacramento River winter-run Chinook salmon, Snake

River fall-run Chinook salmon, Snake River spring/summer-run Chinook salmon, Upper Willamette River Chinook salmon, Columbia River Chinook salmon, Hood Canal summer-run chum salmon, Central California coast coho salmon, Lower Columbia River coho salmon, Southern Oregon and Northern California coast coho salmon, Ozette Lake sockeye salmon, Snake River sockeye salmon, Central California coast steelhead, Puget Sound steelhead, Snake River steelhead, Upper Columbia River steelhead, Southern California steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, Upper Willamette River steelhead, Northern California steelhead, South-Central California coast steelhead, and California Central Valley steelhead, green sea turtle, loggerhead sea turtle, leatherback sea turtle, olive ridley sea turtle, blue whales, bowhead whales, sperm whales, sei whales, humpback whales, fin whales, northern right whales, and southern resident killer whales, and Guadalupe fur seals.

Summary descriptions of these species and critical habitats were provided by the Permits Division in Chapter 3 of the PEIS and were also described and summarized by NMFS in the 2007 Biological Opinion. Updated information about Steller sea lions and the Cook Inlet DPS of beluga whales was provided by the Permits Division in the document entitled "*Summary Document Steller Sea Lion and Northern Fur Seal Research Final Programmatic Environmental Impact Statement January 2009*". This document summarized changes to the FPEIS since the consultation in 2007 and was provided to the Alaska Region as part of the reinitation package. Section 3.2.3 of the Summary Document (page 9) summarized information on other species, included listed species, included in the previous PEIS. It stated (bolded text not in original):

> "Sections 3.2.3 -3.2.7 of the PEIS described…species…that could occur in the project area addressed in the PEIS. These sections include descriptions of "….other listed ESA-species (3.2.4)…Some species, such as killer whales, have been subject to a substantial amount of research since 2007 but the **PEIS found no substantial effects of SSL and NFS research on any of these other species. NMFS does not foresee any significant changes in the nature of effects of SSL or NFS research on these species. u"(sic)pdates to the baseline information on other species are not warranted.**"

Section 4 of the Summary Document describes "new information that has become available since the PEIS was published….and that is pertinent to the analyses and conclusions" about the environmental consequences of the proposed action. Section 4.8.3 summarizes new pertinent information that is available about "other ESA-Listed Species" (other than Steller sea lions." This section, in its entirety, states (bolded text not in original):

> "Section 4.8.3 of the PEIS described the effects of the proposed research on non-target ESA listed species. Although there were updates to the status of four species (Cook Inlet beluga whale, ringed, spotted and bearded seals—Section 3.2.4), **the effects of the research on these species has not changed**. **During research, encounters with these species are rare as study areas and species habitat do not overlap**."

We have reviewed the best available information related to the status, distribution, abundance, habitat use, and ecology of these species. We have reviewed also how the proposed action is modified from the scope of the action consulted on in 2007. We have reviewed information about the proposed action, listed species and critical habitats that may occur within the action area, and the potential effects of the proposed action on such species and critical habitat that is available to us, including, but not limited to: the FPEIS, the Summary Document, and the Policy and Guidance document. All of these documents were provided as part of the reinitiation package. We have also reviewed information in the 2007 Biological Opinion; and other information about Steller sea lion and Northern fur seal research and the listed species and critical habitats that could occur in the action area. This other information includes, but was not limited to:

> The 2008 Alaska Marine Mammal Stock Assessments (Angliss and Allen 2008) (available at http://www.nmfs.noaa.gov/pr/pdfs/sars/ak2008.pdf); the 2008 Cook Inlet Beluga Whale Subsistence Harvest Final Supplemental Environmental Impact Statement (NMFS, 2008); the 2008 Conservation Plan for the Cook Inlet Beluga Whale (*Delphinapterus leucas*) October 2008 (NMFS 2008); Review of the Status of the Right Whales in the North Atlantic and North Pacific Oceans (NMFS 2006) (available at: http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/rightwhale2006.pdf); the SPLASH Final Report (Calambokidis et al.2008); the Draft Recovery Plan For The Fin Whale (*Balaenoptera physalus*) (NMFS 2006) (available at: http://www.nmfs.noaa.gov/pr/pdfs/recovery/draft_finwhale.pdf); the Draft Recovery Plan For The Sperm Whale (*Physeter macrocephalus*) (NMFS 2006); the Recovery Plan for the Blue Whale (*Balaenoptera musculus*) (NMFS 1998); the Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*) (NMFS 2008); status updates for West Coast Salmon and Steelhead and other relevant information about population status, range, habitat use and ecology of these listed fish species (available at http://www.nwr.noaa.gov/ and http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Alsea-Response/Final-Listings-Hatchery-Policy.cfm); the Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead (available at http://www.nwr.noaa.gov/Publications/Biological-Status-Reviews/loader.cfm?csModule=security/getfile&pageid=21346); the Olive Ridley Sea Turtle (*Lepidochelys olivacea*) 5-year Review: Summary and Evaluation (NMFS 2007) (available at http://www.nmfs.noaa.gov/pr/pdfs/species/oliveridley_5yearreview.pdf); the Leatherback Sea Turtle (*Dermochelys coriacea*) 5-Year review: Summary and Evaluation) (NMFS 2007b); 90-Day Finding for a Petition to Reclassify the Loggerhead Turtle in the North Pacific Ocean as a "DPS" with Endangered Status and to Designate Critical Habitat (72 FR 64585); Loggerhead Sea Turtle (*Caretta caretta*) 5-Year review: Summary and Evaluation; Green Sea turtle (*Chelonia mydas*) 5-Year review: Summary and Evaluation; and published and unpublished reports and papers on the relevant species and habitats.

We are not aware of any information that indicates the aforementioned conclusion in the 2007 Biological Opinion would not apply to the current action. Thus, of the listed species considered in the 2007 Biological Opinion, we conclude that formal consultation is not required for those ESA-listed species considered in the 2007 Biological opinion, with the exception of the eastern and the western DPSs of Steller sea lion and their critical habitat. In the sections below, we summarize this available information about the status of these species and designated critical habitats:

- the eastern DPS of Steller sea lions
- the western DPS of Steller sea lions
- Steller sea lion designated critical habitat

Sources of information include, but are not limited to: the Alaska Marine Mammal Stock Assessments (Angliss and Outlaw 2005, 2006, 2008); recent Biological Opinions (NMFS 2000); Recovery and Conservation Plans; peer-reviewed scientific literature; Alaska Fisheries Science Center Technical Reports and other unpublished reports, including but not limited to grant and permit annual reports; white papers; research summaries from government agencies, academic institutions, and private industry; and communication with species experts and observers as identified in the literature cited. We have appended a copy of the 2007 Biological Opinion to facilitate reference to information provided therein. The information considered in this opinion represents the best scientific and commercial data available. In the sections below, we summarize this available information about the status of these species and critical habitats. For each species, we summarize key recent analytical documents which are available and which we reviewed as part of our analysis.

As the proposed action includes direct research focused on Steller sea lions, as the 2007 Biological Opinion concluded that Steller sea lions could be adversely affected by the limited implementation of the Preferred Alternative that was considered therein, and because our own review indicated that the two DPSs of Steller sea lions are the listed species most likely to be affected by the proposed action, we provide more detail about the status of these two DPSs than about other listed species. We have highlighted some information that is particularly relevant to assessing the potential impacts of the proposed action on Steller sea lions.

3.2 Steller Sea Lion: Western and Eastern Distinct Population Segments

Because of the research that has been directed towards understanding Steller sea lions, there is new information since the writing of the 2007 Opinion that we have considered in our description of the status of the species, the description of the baseline, the evaluation of effects and cumulative effects, and in our conclusions about the potential effects of this action. NMFS (2008) summarized some of this information in the Final Revised Steller Sea Lion Recovery Plan. Other documents that summarize a large volume of information about Steller sea lions include, but are not limited to: the Alaska Marine Mammal Stock Assessments (Angliss and Outlaw 2005, 2006; Angliss and Allen 2008); the FMP Biological Opinion (NMFS 2000); the Biological Opinion on Authorization of the BSAI and GOA groundfish fisheries (NMFS 2001) and Supplement (NMFS 2003); Environmental Impact Statements and Assessments related to research permitting (NMFS 2002, 2007) and fishery management, the National Research Council (2003) volume "Decline of the Steller Sea Lion in Alaskan waters: untangling food webs and fishing nets"; and chapters within the volume "Sea Lions of the World (Trites et al. 2006).

In the sections below, we provide updates of information that is helpful for understanding the effects of the proposed action on Steller sea lions.

3.2.1 Species Description

The Steller sea lion (*Eumetopias jubatus*) belongs to the Order Carnivora, Suborder Pinnipedia, Family Otariidae, and Subfamily Otariinae. The family contains the extant genera *Arctocephalus*, *Callorhinus*, *Eumetopias*, *Neophoca*, *Otaria*, *Phocarctos*, and *Zalophus*. The genus *Eumetopias* contains one species, the Steller (also called northern) sea lion, *E. jubatus*. As the Steller sea lion is the only extant representative of its genus, research cannot be done on another member of the genus in lieu of research on this listed species. The extinction of the Steller sea lion would also result in the loss of a genus.

Steller sea lions are the largest otariid and show marked sexual dimorphism with males larger than females. The average standard length is 282 cm for adult males and 228 cm for adult females (maximum of about 325 cm and 290 cm, respectively); weight of males averages 566 kg and females 263 kg (maximum of about 1,120 kg and 350 kg) (Fiscus 1961, Calkins and Pitcher 1982, Loughlin and Nelson 1986, Winship *et al*. 2001). The pelage is light buff to reddish brown and slightly darker on the chest and abdomen. Naked parts of the skin are black (King 1954). Adult males have long, coarse hair on the chest, shoulders, and back; the chest and neck are massive and muscular. Newborn pups are about 1 m long, weigh 16-23 kg, and have a thick, dark-brown coat that molts to lighter brown after 6 months (Daniel 2003). A more detailed physical description is given in Loughlin *et al*. (1987) and Hoover (1988). The marked sexual dimorphism and large size of adults, but especially of adult males, are both features of Steller sea lion morphology that are important in the evaluation of research effects. Smaller animals are vulnerable to injury or even death if trampled by adults, again especially males. The large size of Steller sea lion adults also makes their capture, handling, and even salvage (of dead animals) more challenging than many other pinnipeds

3.2.2 Listing History

In the 1950s, the worldwide abundance of Steller sea lions was estimated at 240,000 to 300,000 animals, with a range which stretched across the Pacific Rim from southern California, Canada, Alaska, and into Russia and northern Japan (Figure 3.1). By 1990, the U.S. portion of the population had declined by about 80%. On April 5, 1990, NMFS (55 FR 12645) issued and emergency interim rule listing the Steller sea lion as threatened and requesting public comment. On November 26, 1990, NMFS (55 FR 49204) issued the final rule to list Steller sea lions as a threatened species under the ESA. In the Final Rule (55 FR 49204), NMFS summarized that sea lions were being listed:

> "…because of significant declines in the Steller sea lion population. The number of Steller sea lions observed on certain rookeries in Alaska has declined by 63% since 1985 and by 82% since 1960. Declines are occurring in previously stable areas. Significant declines have also occurred on the Kuril Islands, USSR."

In the 1980s, annual rates of decline in the range of what is now recognized as the western population were as high as 15% per year. After listing in 1990, the rate of decline decreased to about 5% per year.

Critical habitat was designated on August 27, 1993 (58 FR 45269) based on the location of terrestrial rookery and haulout sites, spatial extent of foraging trips, and availability of prey items (Tables 2.39 and 2.40; Figures 2.14 and 2.15). In the final rule, NMFS summarized that:

> "The physical and biological habitat features that support reproduction, foraging, rest and refuge are essential to the conservation of the Steller sea lion. For the Steller sea lion, essential habitat includes terrestrial, air, and aquatic areas."

Later in this rule, with respect to the terrestrial habitat, specifically, NMFS cited Mate (1973) and summarized that:

> "Factors that influence the suitability of a particular area include substrate, exposure to wind and waves, the extent and type of human activities and disturbance in the region, and proximity to prey resources."

With respect to aquatic habitat specifically, NMFS summarized that:

> "The principal, essential at-sea activity presumably is feeding."

Later in the document NMFS concluded:

> "Adequate food resources are an essential component of the Steller sea lion's aquatic habitat."

In 1997, after continued declines in Alaska, NMFS reclassified Steller sea lions as two distinct population segments under the ESA based on genetic studies and phylogeographical analyses from across the species' range (Bickham *et al*. 1996; Loughlin 1997) (62 FR 24345; 62 FR 30772). At this time, the western DPS, extending from Japan around the Pacific rim to Cape Suckling in Alaska (144°W), was up-listed to endangered status due to its continuous decline and lack of recovery. This endangered status listing was supported by a Population Viability Analysis (PVA) indicating a continued decline at the 1985-1994 rate would result in extinction of the western DPS in 100 years or a 65% chance of extinction if the 1989-1994 trend continued for 100 years (62 FR 24354), The eastern DPS, extending from Cape Suckling east to British Columbia and south to California, remained on the list as threatened because of concern over western DPS animals ranging into the east, the larger decline overall in the U.S. population, human interactions, and the lack of recovery in California (62 FR 24354).

3.2.3 Population Distribution and Structure

Knowledge of the distribution and population structure of a listed entity is highly important to assessing and understanding the effects that potential anthropogenic or natural factors may have on the long-term viability of a population and, in the case of an ESA-listed species, its ability to recover. Hence, knowledge of the underlying population distribution and structure of Steller sea lions has benefits to the formulation of recovery strategies for the listed DPSs of that species. Because of research that has occurred at many locations throughout the range, NMFS (and the larger scientific community) now has a better understanding about Steller sea lions population distribution and structure than we do about many other listed species.

The range of Steller sea lions extends around the North Pacific Ocean rim from northern Japan, the Kuril Islands and Okhotsk Sea, through the Aleutian Islands and Bering Sea, along Alaska's southern coast, and south to California (Figure 3.1)(Kenyon and Rice 1961, Loughlin *et al.* 1984, 1992). Seal Rocks, at the entrance to Prince William Sound, Alaska, is the northernmost rookery (60°09'N). Currently, Año Nuevo Island off central California is the southernmost rookery (37°06'N). However, some pups were born at San Miguel Island (34°05'N) until 1981. Prior to the decline in the west, most large rookeries were in the Gulf of Alaska and Aleutian Islands (Kenyon and Rice 1961, Calkins and Pitcher 1982, Loughlin *et al.* 1984, 1992, Merrick *et al.* 1987). As the decline continued, rookeries in the west became progressively smaller; consequently, the largest rookeries are now in Southeast Alaska and British Columbia. In 2005, the Forrester Island complex produced 3,429 pups and Hazy Islands 1,286 pups (both in Southeast Alaska). About 2,500 pups were counted at the Scott Islands rookery in British Columbia in 2002. In 2005, Ugamak Island (687 pups) and Pinnacle Rock (643 pups) were the largest rookeries in the Gulf of Alaska and Aleutian Islands.

Most adult Steller sea lions occupy rookeries[2] during the pupping and breeding season, which extends from late May to early July (Pitcher and Calkins 1981, Gisiner 1985). During the breeding season some juveniles and non-breeding adults occur at or near the rookeries, but most are on haulouts. Adult males, in particular, may disperse widely after the breeding season. Males that breed in California move north after the breeding season and are rarely seen in California or Oregon except from May through August (Mate 1973). During fall and winter many sea lions disperse from rookeries and increase use of haulouts, particularly terrestrial sites but also sea ice in the Bering Sea.

Steller sea lions are not known to make regular migrations, but they do move considerable distances (Baba *et al.* 2000; Raum-Suryan *et al.* 2002). Animals marked as pups on rookeries in the Gulf of Alaska have been sighted in Southeast Alaska and British Columbia; some marked in British Columbia have been seen at Cape Saint Elias, Alaska; some marked in the eastern Aleutians have been seen in eastern Bristol Bay, Alaska; and some marked in Oregon have been seen in northern California, Washington, British Columbia, Southeast Alaska, and the northern Gulf of Alaska (Calkins and Pitcher 1982, Calkins 1986, Loughlin 1997). Raum-Suryan *et al.* (2002) analyzed resightings of 8,596 pups that were branded from 1975-1995 on rookeries in Alaska and reported that almost all resightings of young-of-the-year were within 500 km of the rookery where the pup was born, although subsequent observations documented movements of 11 month-old pups with their mothers of over 800 km. Juvenile animals were seen at much greater distances from their rookery of birth (up to 1,785 km). Sightings of adults

2 Throughout this document a rookery refers to a site where pups are born (usually a count of 50 or more pups), breeding occurs and sea lions may haulout during the non-breeding period; a site designated as a rookery will be called a rookery the entire year, even though breeding occurs there only from late May to early July.

were generally less than 500 km away from the natal rookery although adult males have since been seen over 1000 km from the rookery where they held a territory (also their natal rookery).

Steller sea lion pups tagged in the Kuril Islands commonly moved northward to the east and west coasts of Kamchatka (Burkanov *et al*. 1997) and have also been seen as far south as Yokahama, Japan (Baba *et al.* 2000, NMFS unpublished data). Pups tagged on the Commander Islands have moved to the east coast of Kamchatka (Burkanov *et al.* 1997). Juveniles marked in the central Aleutian Islands have been observed in the Commander Islands.

Mitochondrial DNA (mtDNA) has been the primary type of genetic material examined to evaluate patterns of genetic variability within and among sea lions from various populations and rookeries throughout their range. This type of DNA typically exhibits maternal inheritance, meaning that offspring inherit their mother's sequence (barring mutation). Bickham *et al*. (1996) reported on analyses of characteristics of mtDNA from 224 Steller sea lions sampled between the Commander Islands and Oregon. The researchers found a high level of genetic diversity with a large number of haplotypes occurring at a relatively low frequency (46 of 52 haplotypes with a frequency less than 0.03). Additional analyses from over 1200 sea lions identified over 130 haplotypes range-wide (Bickham *et al*. 1998a, Ream 2002). A distinct break in the distribution of haplotypes was found between locations sampled in the western part of the range (Russia to the eastern Gulf of Alaska) and eastern locations (Southeast Alaska and Oregon), indicating restricted gene flow between two populations (Figure I-1). These researchers speculated that the two populations did not evolve from a single maternal ancestor but rather descended from the genetic makeup of two populations that inhabited separate glacial refugia during the last ice age.

Loughlin (1997) reviewed information on genetics, together with what is known about distribution, population response, and phenotypic characteristics, to identify Steller sea lion populations. He found that the strongest support for multiple populations came from the genetics results described above, but information on distribution and movement patterns and population responses provided additional support. Loughlin concluded that Steller sea lions should be managed as two populations, an eastern population that includes all animals born on rookeries east of Cape Suckling, Alaska, and a western DPS that includes all animals born at rookeries west of Cape Suckling. NMFS accepted this recommendation and, as noted above, in 1997 reclassified Steller sea lions as two distinct population segments under the ESA (62 FR 24345, 62 FR 30772).

The eastern DPS includes sea lions born on rookeries from California north through Southeast Alaska. The western DPS includes those animals born on rookeries from Prince William Sound westward (Bickham et al. 1996, Loughlin 1997). The regulatory division between DPSs is Cape Suckling (144º west longitude) in the northeast Gulf of Alaska. However, as noted above, movement across this boundary by animals (particularly juveniles) from both populations does occur (Raum-Suryan *et al.* 2002, and see references given below).

Bickham et al. (1998a) analyzed mtDNA from an additional 191 Steller sea lions, mostly from regions not sampled in their previous study, (e.g., Kuril Islands, British Columbia, and California). The results from those samples combined with previous results confirmed the high degree of genetic differentiation between eastern and western DPSs. Bickham et al. (1998b) also analyzed mtDNA from 36 Steller sea lions sampled in the Gulf of Alaska in 1976-1978 and compared the results with samples collected in the 1990s following the steepest population decline (Bickham et al. 1996). They found that the high level of haplotypic diversity previously noted for the present population had been maintained between the two sampling periods. Thus, genetic diversity of Gulf of Alaska sea lions had been retained in spite of the recent major decline in abundance. Phylogenetic analysis by Harlin-Cognato et al. (2006) suggests that the current genetic structure of sea lions is the result of Pleistocene glacial geology which influenced the availability of suitable rookery habitat.

Substantial additional genetic research was conducted with larger samples from throughout the Steller sea lion range, including most rookeries in Russia. The results of these studies generally confirm the strong east/west population delineation, but differ in their description of further structure within the western DPS when looking either at mtDNA or nuclear DNA (Trujillo et al. 2004, Baker et al. 2005, Hoffman et al. 2006, NMFS unpublished data). A further complexity is the possibility that the geographic boundary between the western and eastern populations may be changing or possibly disappearing (Pitcher et al. 2007, NMFS unpublished). Trujillo et al. (2004) examined mtDNA and nuclear DNA from the same samples to show that the population separation apparent from the mtDNA work was not clearly defined when males were taken into account. There was no clear separation of populations based on genetics when markers from both parents were included. They suggested that the difference was either due to a faster population divergence at the mtDNA locus or that, like many other mammals, Steller sea lions show a greater level of male-mediated gene flow via immigration than in females, ie., males tend to disperse more than females and do not show the same philopatry for their natal areas as females. Support for this result also comes from observational work in the eastern DPS with the monitoring of branded animals. Resights of animals branded as pups in one DPS have been reported occasionally at haulouts and rookeries within the other DPS.

Based on analyses of sequence variability at a segment of the mtDNA control region in samples from 1,568 individuals representing nearly every significant rookery rangewide, Baker et al.(2005) hypothesized that a third population (termed by the authors the Asian stock, including rookeries from the Kamchatka Peninsula, Kuril Islands, and Sea of Okhotsk) may exist just west of the Commander Islands in Russia. They recommended that the western stock be partitioned west of the Commander Islands, yielding a western stock that ranges from Prince William Sound west to the Commander Islands, and an Asian stock that includes rookeries from the Kamchatka Peninsula, Kuril Islands, and Sea of Okhotsk. However, the level of differentiation between the putative Asian and western stock was not as great as that between the eastern and western stocks. Other significant findings from this study included: no evidence for significant genetic bottleneck effects; support for significant divergence of eastern stock (southeastern Alaska to California) animals from western stock animals; significant differences between rookeries and regions along Asia from all other western stock rookeries; clear association of the Commander Islands rookery with Alaskan western stock rookeries, not with the Russian (termed Asian) rookeries; and significant isolation by distance among rookeries within, but not among, the stocks, indicating that there may be important gene flow barriers among stocks. Based on the findings from this study, conclusions about the eastern stock would remain unchanged, i.e., that stock would include rookeries from southeastern Alaska through California.

Hoffman et al. (2006) followed up on the research by Baker et al. (2005) by genotyping over 700 individuals from across the species range at 13 highly polymorphic nuclear (inherited from both parents) microsatellite loci. They found that although there was strong female philopatry (as described by mtDNA methods), there was little evidence to support the separation of an Asian DPS due to potentially extensive male gene flow. These investigators also detected a clear phylogenetic break between populations of the western and Asian stocks and those of the eastern stock. Hoffman et al. (2006:2821) concluded that "mtDNA structuring is not due simply to female philopatry, but instead reflects a genuine discontinuity within the range, with implications for both the phylogeography and conservation of this important marine mammal."

Conclusions of Raum-Suryan et al. (2002) support the hypothesis that Steller sea lions conform to the metapopulation model. Similarly, other unpublished research funded by NOAA Fisheries focusing on population structure within the western and eastern DPSs in the U.S. has also shown that there may be additional population structure within the western DPS, specifically with a split at Samalga Pass (O'Corry-Crowe et al 2006).

Recently, Hoffman et al. (2009) evaluated new data for amplified fragment length polymorphism (AFLP) markers, comprising 238 loci, scored in 285 sea lions from 23 natal rookeries. When considered in concert with previously published mitochondrial DNA(mtDNA) and microsatellite data sets, they found contrasting geographical patterns of genetic diversity were found at the three markers. Nei's gene diversity was tending to be higher for AFLPs and microsatellites in rookeries of the western and what they termed the "Asian" stock. The highest mtDNA values were found in the eastern stock. They concluded that the Steller's sea lion has unusually low diversity even compared with related species, with potential management implications. " However, these authors did not find significant trends between genetic diversity and colony size or demography.

Steller sea lions may sometimes disperse from their rookeries of birth and breed at other rookeries within their parent populations; this has the potential to affect local population dynamics and thus conforms to the concept of a "metapopulation" (Hanski and Simberloff 1997). York *et al*. (1996) suggested that in the case of Steller sea lions, a metapopulation may be considered a rookery or cluster of rookeries. Occasional dispersal of animals from their natal rookeries may have important consequences for expansion of the eastern population and possible recovery of the western DPS, as it provides a mechanism for occupying new territory or re-occupying vacant areas (Raum-Suryan *et al*. 2002). Of the two most recently established rookeries in the eastern DPS, about 70% of the pups born on Graves Rock were from western DPS females, and about 45% of the pups born at White Sisters were from western DPS females (NMFS unpublished, Gelatt *et al*. 2006). In addition, recent mtDNA work with large samples of pups from newly established rookeries in the eastern DPS has shown that some females born in the western DPS are pupping in the eastern DPS (NMFS unpublished data; see below). Because these samples were collected from rookeries that were not yet established at the time of the ESA designation, they were not included in the original genetic studies. In Southeast Alaska, new rookeries were established as population size increased, at least partially the result of dispersal from the large Forrester Island rookery (Calkins *et al*. 1999, Raum-Suryan *et al*. 2002, Pitcher et al. 2007, ADF&G unpublished data) and from the western DPS (NMFS unpublished, Pitcher *et al.* 2007).

Movement inferred from the genetics data has been confirmed by the sighting of western branded females with pups at Graves Rock and White Sisters (NMFS unpublished). This movement of females from the western stock to locations within range of the eastern stock for the purpose of pupping and presumably, for breeding, has potential long term implications to the viability of these populations and their management. It is possible that we are witnessing in real-time a very infrequent event in which female sea lions from one population cross over to breed in another.

New data about the dispersal, patterns of genetic variation, and breeding site selection continue to refine NMFS's understanding of the underlying population structure. These data generally confirm genetic differentiation of the two DPS's but conclusions about a third population in Asia have varied between studies focused on different genetic markers. Movements of sea lions between the ranges of the two DPSs do occur and animals will sometimes disperse from their natal rookery and breed elsewhere, usually within the same DPS.

3.1.4 Population Status and Trends

Underlying Methodology.--Count data used to estimate the trend of Steller sea lion population abundance and pup production are of two types: counts of pups about 1 month of age and counts of animals over 1 year of age (i.e., non-pups).

Until recently, counts of pups were usually made by observers on rookeries, herding the non-pups into the water, and walking through the rookery and counting the pups (Calkins and Pitcher 1982, Sease *et al*. 2001). Beginning in 2002, 126mm format aerial photography has also been used to count pups (Westlake *et al*. 1997, Snyder *et al*. 2001). In British Columbia, pup counts were made from 35mm slides taken during aerial surveys flown specifically to facilitate pup counts (vertical orientation).

Counts of pups on rookeries conducted near the end of the birthing season are a measure of pup production. These counts can be expanded to estimate approximate total population size based on an estimated ratio of pups to non-pups in the population (Calkins and Pitcher 1982, Trites and Larkin 1996). Based on estimates of birth rate and sex and age structure of a stable sea lion population from the Gulf of Alaska, Calkins and Pitcher (1982) estimated total population size was 4.5 times the number of pups born. Because some pups die and disappear before the counts are made, and because a few are born after the counts are conducted (Trites and Larkin 1996), the researchers selected 5.1 as a correction factor (to correct for the fact that some pups that are produced are not counted). Using this methodology, estimates of population size are general estimates because temporal and spatial variation in underlying population characteristics (e.g., age structure, sex ratio, birth rates and mortality rates) can affect the accuracy of this correction factor.

Non-pups have been counted in most instances from 35 mm color slides taken from aircraft during the breeding season (Calkins and Pitcher 1982, Merrick *et al.* 1987, Sease *et al.* 2001). However, in recent years some counts were made from 126mm format aerial photographs. Counts from 35 mm slides and medium format photographs were highly correlated but, on average, slightly higher counts were obtained from medium-format photographs (Fritz and Stinchcomb 2005).

Counts of both pups and non-pups were used to estimate trend for the various geographic areas and sub-regions depending on availability of data. Trend analysis was conducted by linear regression of the natural logarithms of the counts by year. For the western DPS, estimates of population trend, an index to changes in absolute population abundance, were based on comparisons of counts among years at a group of sites consistently monitored since the 1970s (trend sites). Trend sites include the majority of animals observed in each survey (e.g., 72% in 1998, 75% in 2000; Sease *et al.* 2001). "Trend rookeries" are a subset of all trend sites and include all major rookeries except those on Outer and Attu Islands. Counts of pups on rookeries are also used to estimate population trend.

Non-pup numbers used for population trend assessment are sums of counts at sites within sub-areas or across the range of the western stock in Alaska. Replicate surveys conducted in 1992 and 1994 confirmed NMFS understanding of sea lion haul-out behavior patterns. The number of sea lions on individual haul-outs can vary considerably from day to day, while numbers on rookeries tend to be more stable. However, if surveys are conducted in mid-June during the height of the breeding season, the sum of counts at all consistently surveyed sites within a sub-area has a much lower variance than the counts at any individual site. This is due to movement between sites within the same sub-area. Coefficients of variation associated with sub-area non-pup totals range between 5-15% (NMFS, unpublished data). NMFS designed a monitoring plan using the established survey techniques to estimate the impact of fishery management measures, and determined that there was a greater than 90% chance of detecting a 1% per year change in population size over 8 years (4 surveys) (NMFS 2000).

<u>Findings</u>.--From the late 1960s through 2000, the western DPS declined over 80% in abundance, with steepest declines of approximately 15% per year occurring in the late 1980s and slower declines of about 5% per year in the 1990s (based on non-pup counts; Loughlin *et al.* 1992, Trites and Larkin 1996, Loughlin 1997, Sease and Loughlin 1999). Between 2000 and 2004, counts of non-pups on western DPS trend sites increased or were stable through much of the Alaskan range (Sease and Gudmundson 2002, Fritz and Stinchcomb 2005). In 2004, the western DPS was estimated to have been composed of about 45,000 sea lions in Alaska and approximately 16,000 in Asia (NMFS 2008).

The specific causes of the decline are not known, and the relative importance of various factors may have changed over time. While there is no consensus on the causes of the sharp decline in the 1980s or consensus on why the population declined at a slower rate through the 1990s, several factors have been proposed and have some degree of support. Direct mortality through incidental take in fisheries, commercial harvests, illegal shooting (Perez and Loughlin 1991, Alverson 1992, Trites and Larkin 1992) and/or predation (Springer et al. 2003; 2008) have all been proposed as potentially contributing factors in the sharp rates of decline in the 1980s. A reduction in survival and possibly fecundity due to a reduced or modified prey base has also been proposed as a factor in the decline. This could have resulted from commercial fisheries (Fritz *et al*. 1995, Loughlin 1998), from a major regime shift in the mid-1970s (Trenberth 1990, Springer 1998, Benson and Trites 2002, Le Boeuf and Crocker 2005, Trites *et al.* 2006a), or from the effects and/or the interactions of both. Steller sea lions are not the only population of marine mammals to undergo a substantial decline in portions of western Alaska. Harbor seals (Pitcher 1990, Frost *et al*. 1999, Small *et al*. 2003, Ver Hoef 2003), northern fur seals (Trites 1992, Towell *et al.* 2006), and sea otters (Estes *et al.* 1998, Doroff *et al*. 2003) have all declined substantially over at least portions of the range of the western DPS of Steller sea lion. Potential factors underlying the decline of the Steller sea lion are reviewed in more detail in the Baseline section of this Biological Opinion, in the 2008 Recovery Plan, and in Biological Opinions on the effects of the federally managed groundfish fisheries in the Gulf of Alaska, Bering Sea, and Aleutian Islands (NMFS 2000, 2001, 2003).

In contrast to the decline and lack of recovery documented in the western DPS, data summarized by Pitcher et al (2007) indicates that the eastern DPS increased at about 3% per year from the late 1970s through 2002. Currently, this population is estimated to be at its highest level in recent history, numbering 46,000 to 58,000 animals in 2002 (Pitcher et al. 2007). Recent data from Southeast Alaska (2005) and California (2004) suggest continued population growth. Legal protection, both in the United States and Canada, probably played an important role in population growth.

3.1.4.1 Worldwide Trend

Loughlin *et al.* (1984) estimated the worldwide population of Steller sea lions was between 245,000 and 290,000 animals (including pups) in the late 1970s (1974-80). Though the genetic differences between the eastern and western DPSs were not known at the time, Loughlin *et al.* (1984) noted that 90% of the worldwide population of Steller sea lions was in range of what is now recognized as the western DPS in the early 1980s (75% in the U.S. and 15% in Russia) and 10% in the eastern DPS. Loughlin *et al.* (1984) concluded that the total worldwide population size (both DPSs) was not significantly different from that estimated by Kenyon and Rice (1961) for the years 1959 and 1960, though the distribution of animals had changed. After conducting a range-wide survey in 1989, Loughlin *et al.* (1992) noted that the worldwide Steller sea lion population had declined by over 50% in the 1980s, to approximately 116,000 animals, with the entire decline occurring in the range of the western DPS.

3.1.4.1 Western DPS Status and Trend

The western DPS of Steller sea lion breeds on rookeries in Alaska from Prince William Sound (144°W) west through the Aleutian Islands and in Russia on the Kamchatka peninsula, Kuril Islands and the Sea of Okhotsk (Bickham *et al.* 1996, Loughlin 1997).

Alaska (U.S. portion of the range)

<u>Non-pup trend</u>.--Steller sea lions use 38 rookeries and hundreds of haul-out sites within the range of the western DPS in Alaska. The first reported counts of Steller sea lions in Alaska

were made in 1956-1960 (Kenyon and Rice 1961, Mathisen and Lopp 1963), and these totaled approximately 140,000 for the Gulf of Alaska (GOA) and Aleutian Islands (AI) regions (Merrick *et al.* 1987)[3] [4].

Subsequent surveys showed a major decline in numbers first detected in the eastern AI in the mid-1970s (Braham *et al.* 1980). The decline spread eastward to the central GOA during the late 1970s and early 1980s and westward to the central and western AI during the early and mid 1980s (Merrick *et al.* 1987, Byrd 1989). Approximately 110,000 adult and juvenile sea lions were counted in the Kenai-Kiska region in 1976-1979, and by 1985 and 1989, counts had dropped to about 68,000 (Merrick *et al.* 1987) and 25,000 (Loughlin *et al.* 1990), respectively. Since 1990 when Steller sea lions were listed under the ESA, complete surveys have been conducted throughout their range in Alaska every one or two years (Merrick *et al.* 1991, 1992, Sease *et al.* 1993, 1999, 2001, Strick *et al.* 1997, Sease and Loughlin 1999, Sease and Gudmundson 2002, Sease and York 2003, Fritz and Stinchcomb 2005). Complete non-pup surveys were not possible in 2006 and 2008, but were in 2008 (Fritz et al. 2008, 2009) (see below).

Steller sea lion populations in parts of the Alaskan range of the western DPS may have begun to drop between the late 1950s and the mid 1970s (Table 3.1[5]). From the mid-1970s to 1990 the overall western DPS in Alaska declined by over 70%, with the largest declines in the AI (76% to 84%) and smaller declines in the GOA (23% to 71%). Between 1990 and 2000, trend site counts continued to decline, though more slowly than in the 1980s, resulting in a total reduction of almost 90% since the 1950s and 83% since the 1970. Sub-area declines from 1990 to 2000 had a different pattern than in the 1970s-1990 period, with smaller changes in the center of the Alaskan range (western GOA and eastern and central Aleutians: -32% to +1%) and larger declines at the edges (eastern and central GOA and western Aleutians: -54% to –64%). The average rate of decline between 1990 and 2000 for all trend sites in the western DPS was 5.1% per year (Sease *et al.* 2001).

Between 2000 and 2004, Kenai-Kiska and western Alaska population trend site counts of non-pup Steller sea lions increased by 11-12%, or at about 3%/year (Fritz and Stinchcomb 2005). Increases were not spread evenly across the range in Alaska, however. Non-pup counts increased by over 20% in the eastern Aleutian Islands and in the eastern and western GOA, and by 10% in the central Aleutian Islands, but were lower by as much as 16% in the central GOA

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[3] For the western DPS of Steller sea lion in Alaska, count data have generally been combined and analyzed in six subareas (Figure 3.2), which are geographically convenient but do not necessarily reflect biologically important units. Because earlier efforts to count sea lions were concentrated in the center of their Alaskan range, evaluations of long-term trends have often been calculated for the "Kenai to Kiska" index area, which includes the central and western Gulf of Alaska and the eastern and central Aleutian Islands.

[4] Nelson (1887) reported on natural history collections taken in Alaska from 1877-1881. They estimated large numbers of Steller sea lions in the Pribilof Islands (over 25,000) and relatively low numbers throughout the Aleutian Island chain. This information seems to be based on conversations with Aleuts and their hunting experience as well as with westerners on the Pribilof Islands. Their methods are unclear and impossible to evaluate. In general, they indicate that there may have been some dense aggregations of sea lions but otherwise somewhat scarce (relative to the Pribilofs) throughout the Aleutians.

[5] In some cases the counts shown in this table are lower than total survey counts given above (and used in some other reports) because not all sites counted in a survey are trend sites.

and western Aleutians. While overall non-pup counts from 2000 to 2004 increased, counts in the western GOA and eastern AI had essentially no trend between 1990 and 2004.

Non-pup surveys conducted in 2006 and 2007 (Fritz *et al*. 2008) did not result in complete assessments of the population (Fritz *et al*. 2008, 2009). In the summer of 2008, NMFS conducted an aerial survey of non-pups from southeast Alaska through to the western end of the Aleutians. This was the first complete survey of the wDPS in Alaska since 2004 (Fritz et al. 2008, 2009), and the first complete survey of the eDPS in southeast Alaska since 2002 (Pitcher et al. 2007). At the request of the North Pacific Fishery Management Council (NPFMC), Fritz et al. (2009) provided analysis of trends in non-pup and pup counts between 2000 to 2008. In addition to summarizing overall trends, these authors provided detailed information about counts at each major rookery as well as trends within site clusters and the main seven subgroupings that have traditionally been used to track SSL trends in Alaska. Because of the importance of this basic information to our understanding of the potential for research on Steller sea lions and Northern fur seals to affect Steller sea lions, and to avoid simply reproducing information already well-summarized, we incorporate the information in that memorandum into this opinion as an appendix (Appendix D) to facilitate access to the information and to allow us to directly reference data provided within it. We provide a general summary of the information here.

In the range of the western DPS within Alaska, the overall trends in non-pup (adult and juvenile) from 2000 to 2008 varied at different parts of the range and over time (Fritz *et al*. 2009); See table from Fritz *et a*l. 2009. Fritz *et al*. (2009) summarized that (bold font not in original):

> During the first four years (2000-2004), Alaska wSSL non-pup counts increased 11%. Most of the 2000-2004 increase occurred in the core region from the Kenai Peninsula through Kiska Island (Kenai-Kiska); decreases west of the Kenai-Kiska region (western Aleutian Islands) were largely balanced by increases to the east (eastern Gulf of Alaska).
>
> During the second four years (2004-2008), Alaska wSSL non-pup counts increased 3% due to greater numbers counted in the eastern Gulf of Alaska. Kenai-Kiska counts were stable, but counts in the western Aleutian Islands continued to decline. Evidence suggests that movement of animals from southeast Alaska (eastern DPS) to haul-outs in the eastern Gulf of Alaska (western DPS) prior to the 2008 survey contributed to higher counts in the eastern Gulf of Alaska and lower than expected counts in southeast Alaska. We do not have a precise estimate of the number of eastern DPS animals counted in the eastern Gulf of Alaska. However, if it is as high as 1,000 (the approximate increase observed between 2004 and 2008 at a single eastern Gulf of Alaska haul-out, Cape St. Elias), then Alaska wSSL non-pup counts would have declined 1% between 2004 and 2008. As a consequence, **we conclude that the recent (2004-2008) trend for adult and juvenile western Steller sea lions in Alaska is stable or declining slightly.**

> Pup production by Steller sea lions in the western DPS in Alaska has been largely stable between 1998 and 2005/07, despite overall increases in non-pup counts between 2000 and 2008. Throughout the western DPS in Alaska, pup counts declined 2% overall in this 7-9 year period, increased 4% in the E GULF and increased about 3% in the Kenai-Kiska core.

The eastern DPS of Steller has been increasing for over 20 years with the greatest increases in southeast Alaska and British Columbia, but generally poor performance in California at the southernmost extent of its range (Pitcher et al. 2007).

Non-pup abundance estimation.--Using the methods described in Loughlin *et al.* (1992), Loughlin (1997) estimated that the non-pup U.S. portion of the western DPS totaled approximately 177,000 animals in the 1960s; 149,000 in the 1970s; 102,000 in 1985; 51,500 in 1989; and only 33,600 in 1994. Using similar methods, Loughlin and York (2000) estimated the number of non-pups in the U.S. portion of the western DPS in 2000 at about 33,000 animals. Using a different method[6], Ferrero *et al.* (2000) and Angliss and Outlaw (2005) estimated the minimum abundance of the U.S. portion of the western DPS in 1998 at 39,031 and in 2001-2004 at 38,206, respectively, a decline of over 80% since the late 1970s. In 2004, the western DPS was estimated to have been composed of about 45,000 sea lions in Alaska and approximately 16,000 in Asia (NMFS 2008).

Pup counts.--Pups have been counted less frequently than non-pups, but the overall trends since the late 1970s have been similar to counts of non-pups. The number of pups counted in the Kenai-Kiska region declined by 70% from the mid-1980s to 1994, with large declines (63% to 81%) in each of the four sub-areas. From 1994 to 2001-02, Kenai-Kiska pup counts decreased another 19%, with the largest change (-39%) observed in the central GOA. The overall decline in the number of pups in the Kenai-Kiska region from the mid-1980s through 2002 was 76%. Pup counts in the eastern GOA (not included in the Kenai-Kiska region) declined by 35% from 1994 to 2002, while in the western Aleutian Islands, pup counts declined by 50% between 1997 and 2002 (Table 3.2). Between 2001-02 and 2005, increases in pup counts were noted in the eastern and western GOA and eastern AI, while pup counts declined in the central GOA and central and western AI. In June-July 2005, a medium format aerial survey for pups was conducted from Prince William Sound to Attu Island, which provided the first complete pup count for all western DPS rookeries and major haulouts in Alaska (n = 9,951 pups; Fritz et al. 2008). Using the "pup" estimator (4.5) yields an estimate of approximately 44,800 Steller sea lions in the range of the western DPS in Alaska.

Pribilof Islands.--The population of Steller sea lions on the Pribilof Islands has seen similar declines, although the trends were initiated much earlier. Elliott (1880) reported that approximately 10,000 to 12,000 animals were distributed at rookeries on both St. Paul and St. George Islands in the 1870s. Osgood *et al.* (1916) described the importance of Steller sea lions to the local community for both food and material for clothing and boats. The pups especially

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[6] Estimated population numbers were based on a pup multiplier (e.g., 5.1 and 4.5 were used), while the minimum population estimates were based on adding the total number of non-pups counted in an aerial survey with the "best" estimate of pups counted.

were favored for their meat. Between 1870 and 1890, at least 4,000 sea lions were killed on St. Paul Island and by the early 1900s the local agent noted that the hunt should cease do to a reduced population (Osgood *et al.* 1916). In 1940, Scheffer counted 800-900 adults and 300-400 pups on St. Paul. He noted that the population was growing and that the sea lions interfered with the management of the fur seal herd by competing for both food and space and "creating a nuisance to the men who drive and kill the seals" (Scheffer 1946). This competition initiated a request to cull part of the population. The recommendation was to kill 50 pups a month during June, July, and August to assess the seasonal quality of the pelts.

The combination of hunting and culling appears to have kept the Pribilof sea lion population at reduced numbers. Loughlin *et al.* (1984) reported that the breeding rookeries on St. George Island were extirpated by 1916. No pups have been reported on St. George since. In the summer of 1960, 4,000 to 5,000 non-pups and 2,866 pups were counted on Walrus Island, just offshore of St. Paul (Kenyon 1962). Between the 1960s and 2005, however, numbers of non-pups and pups on Walrus Island declined over 90%, to 322 non-pups in 2001 and only 29 pups in 2005 (Figure 3.4 and Table 3.2; Loughlin *et al.* 1984, Fritz et al. 2005). The cause of the declines during the last 50 years remains unexplained. Subsistence takes of non-pups have continued on the main islands of St. Paul and St. George averaging 141 during 1992-1998, but declined to less than 100 sea lions in the latter half of the 1990s, (Wolfe and L.B. Hutchinson-Scarbrough 1999), 22, 26, and 34 sea lions were taken on St. Paul Island in 2005, 2006, and 2007 respectively (St. Paul Island Ecosystem Conservation Office). Walrus Island is the only Steller sea lion rookery still active in the Pribilofs, but pup production has declined steadily from 2,866 in 1960 to approximately 334 in 1982, 50 in 1991, 39 in 2001, and only 29 in 2005 (NMFS 1992, Fritz et al. 2008).

Russia and Asia

Steller sea lions use 10 rookeries and approximately 77 haul-out sites within the range of the western DPS in Russia. Of these 77 haul-outs, three had been rookeries, but presently no breeding occurs there, 49 are active haul-out sites, 20 have been abandoned (no sea lions seen there for the past 5-10 years), and five have inadequate information to assess their status. Analysis of available data collected in the former Soviet Union indicates that in the 1960s, the Steller sea lion population totaled about 27,000 (including pups), most of which were in the Kuril Islands. Between 1969 and 1989, numbers of adult and juvenile sea lions at major rookeries and haul-outs in the Kuril Islands alone declined 74% (Merrick *et al.* 1990). By the late 1980s and early 1990s, the total Russian population had declined by approximately 50% to about 13,000 (including pups) (Burkanov and Loughlin 2005). Since the early 1990s, the population has increased in most areas and, in 2005, is estimated to number approximately 16,000 (including pups) (Burkanov and Loughlin 2005.

Trends in counts of non-pup and pup Steller sea lions on selected rookeries and haulout sites have varied by subarea within Russian waters. In the Kuril and Commander Islands and in eastern Kamchatka, Steller sea lion numbers declined through the 1970s and 1980s, but increased slightly or were stable from the early 1990s through 2005 (Figures 3.8 and 3.9). In the western Bering Sea, there are no rookeries; numbers of non-pups have plunged over 90% and since 2000, have totaled less than 100. By contrast, Steller sea lion numbers on Tuleny

Island and at two rookeries in the Sea of Okhotsk (on Iony and Yamsky Islands) have increased considerably in the last 15 years. Overall, counts of non-pups on all Russian trend sites were essentially stable between 1989 and 2004 (an annual rate of change of -0.02%, which is not significantly different from 0; p=0.96). Regional differences in trend have been observed.

The Steller sea lion is listed as an endangered species under Russian legislation. While the Russian government currently has no organized program of monitoring and research, both NMFS and the Alaska SeaLife Center have programs to monitor population trends (non-pup and pup counts), estimate vital rates (branding and re-sighting), collect food habits data, and conduct other research on Steller sea lions in Russia. It is anticipated that research on Russian-Asian sea lions will continue to be supported by both institutions in the near future.

Western DPS overall

The western DPS of Steller sea lions decreased from an estimated 220,000-265,000 animals in the late 1970s to less than 50,000 in 2000. The decline began in the 1970s in the eastern Aleutian Islands (Braham *et al.* 1980), western Bering Sea/Kamchatka and the Kuril Islands. In Alaska, the decline spread and intensified east and west of the eastern Aleutians in the 1980s and persisted at a slower rate through 2000 (Sease *et al.* 2001). The 11-12% increase in numbers of non-pups counted in the Alaskan range of the western DPS between 2000 and 2004 was the first increase observed during more than two decades of systematic surveys. The observed increase, however, has not been spread evenly among all regions of Alaska, nor does it appear to have been sustained through 2007 (Fritz et al. 2008) In Russia, both pup and non-pup data indicate that sea lion numbers are increasing at Sakhalin Island and in the Sea of Okhotsk and likely at the Commander Islands. However, non-pup numbers in Kamchatka and the Kuril Islands, the former core of the Russian range, declined substantially through the late 1980s, but have increased slightly through 2005. The number of western Steller sea lions throughout its range in Alaska and Russia in 2005 is estimated at approximately 60,000 (44,800 in Alaska and 16,000 in Russia).

3.1.4.2 Eastern DPS Status and Trend

The available historical records of Steller sea lion abundance were reviewed for the eastern DPS to relate current population size with levels prior to the initiation of standardized surveys. These records provide interesting insights into relative population levels but must be interpreted with caution because the older counts were obtained by a variety of methods and during varying times of the year. Count data obtained prior to 1970 were not subjected to quantitative analyses because of intermittent availability and concerns about comparability with more recent count data. Counts of both pups and non-pups were used to estimate trends for the various geographic areas depending on availability of data (Figures 3.11 and 3.12). Trend analysis was conducted by linear regression of the natural logarithms of the counts by year.

Population trend was analyzed by geographic regions (Southeast Alaska, British Columbia, Washington, Oregon, and California) as the data were collected by various state and federal agencies in each area. Steller sea lions, particularly juveniles, range widely (Raum-Suryan *et al*. 2002), and therefore population estimates for a particular geographic area represent the number of animals supported by the rookeries in that area and not the exact number of animals present in the area at any time. This is particularly true when large rookeries are located near jurisdictional borders such as the boundaries between Southeast Alaska and British Columbia and between Oregon and California.

Southeast Alaska

Numbers of pups counted on rookeries in Southeast Alaska increased from 2,219 in 1979 to 5,510 in 2005, an annual rate of increase of 3.1%. In 1979, the Forrester Island rookery complex was the only rookery in Southeast Alaska. During the early 1980s, a rookery developed at Hazy Islands, and in the early 1990s at White Sisters. Recently, two additional sites, Graves Rocks and Biali Rocks, appear to have developed into rookeries with 175 and 100 pups counted respectively at the two sites in 2005. Since 1990, nearly all the increase in pup numbers has been at the newer rookeries, as pup numbers at the Forrester Island rookery were stable ($P = 0.302$). In addition to the five rookeries, sea lions used 30 major haulouts, plus several other sites for brief periods each year, probably in conjunction with seasonal prey concentrations.

At four of five rookeries in Southeast Alaska, counts of non-pups increased substantially from 1979 to 2005. Based on 2002 pup counts, estimated Steller sea lion abundance (all age classes) in Southeast Alaska was 21,947 animals (with the 4.5 pup multiplier) or 24,873 (with the 5.1 pup multiplier); by comparison, a total of 20,160 sea lions (pups plus non-pups) were counted during the 2002 survey.

Historical data for this region are scant, yet numbers of Steller sea lions were likely relatively low during the early 1900s when there may not have been any rookeries in Southeast Alaska (Rowley 1929, Imler and Sarber 1947). Numbers have progressively increased since that time (Calkins *et al.* 1999) and are now believed to be at an historical high.

British Columbia

Counts of Steller sea lion pups in British Columbia increased from 941 in 1971 to 3,281 in 2002 (Olesiuk and Trites 2003), an annual rate of increase of 3.2% closely paralleling the trend in Southeast Alaska. Rookeries occur at North Danger Rocks, Cape St. James, and the Scott Islands (Maggot, Triangle, Sartine, and Beresford Islands). Sea lions also use 24 major haulout sites in British Columbia (Olesiuk 2001) plus a number of other seasonal haulouts (Bigg 1988).

Extensive sea lion reduction programs were conducted at many locations in British Columbia from 1912 through 1966, and sea lions were commercially exploited during the 1960s, resulting in the population being reduced to about 30% of peak levels of the early 1900s (Bigg 1988). A major rookery, the Sea Otter Group, was eradicated by about 1940 as a result of intensive control efforts and while sea lions still used it as a haulout it no longer serves as a rookery.

The most recent survey occurred in summer, 2002 and counted 15,402 sea lions including 3,281 pups and 12,121 non-pups (Olesiuk and Trites 2003). Steller sea lion abundance (all age classes) in British Columbia, based on 2002 pup counts at rookeries, was 14,765 animals (with the 4.5 pup multiplier) or 16,733 (with the 5.1 pup multiplier). Olesiuk and Trites (2003) used the raw counts and a multiplier to estimate the total number of animals present in British Columbia waters during the breeding season of 2002 at 18,400 – 19,700 individuals of all ages, including non-breeding animals associated with rookeries in Southeast Alaska and Oregon. It appears that the British Columbia Steller sea lion population has largely recovered from the low levels of the 1970s, particularly when considered in conjunction with the adjoining Southeast Alaska population (Olesiuk 2001).

Washington

No rookeries exist in the state of Washington, but Steller sea lions are present along the coast throughout the year. Four major haulouts are used, and counts of non-pups have been made during the breeding season during most years since 1991, when numbers of sea lions increased at an average of 9.2% annually (Table 3.8). These animals are assumed to be immature animals and non-breeding adults associated with rookeries from other areas. Branded juvenile sea lions from the Forrester Island rookery in Southeast Alaska (Raum-Suryan *et al*. 2002) and from the Rogue Reef rookery in Oregon (Brown unpublished data) have been observed in Washington. Older records suggest that current numbers are reduced from historical levels. Between 2,000 and 3,000 Steller sea lions were reported during August and September of 1914, 1915, and 1916 in the Carroll Island area (Kenyon and Scheffer 1959, Scheffer 1950) while the maximum observed during 60 complete surveys of Washington haulouts between 1980 and 2001 was 1,458 in October, 2000 (non-breeding season count).

Oregon

Steller sea lions occupy two rookeries, located at Rogue Reef and Orford Reef, and eight haulout sites in Oregon. The total number of non-pup sea lions counted during the breeding season surveys at all of these sites has increased from 1,461 in 1977 to 4,169 in 2002 (Brown *et al*. 2002), an annual rate of increase of about 3.7%. Although not nearly as well documented, pup numbers also appear to have increased. In 1996, 685 and 335 pups were counted at Rouge Reef and Orford Reef respectively, whereas in 2002, 746 and 382 pups were counted at the two sites. These counts were made from 126mm format, aerial photographs. Steller sea lion abundance (all age classes) in Oregon, based on 2002 pup counts at rookeries, was 5,076 animals (with the 4.5 pup multiplier) or 5,753 (with the 5.1 pup multiplier). A total of 5,297 animals were actually counted during the 2002 surveys.

Historical data on Steller sea lion abundance in Oregon are sketchy. Pearson and Verts (1970) estimated the population at 1,078 animals in 1968, somewhat lower than the 1977 count of 1,461. Population size was believed to be substantially smaller than in 1925 due to extensive human-caused mortality, in part stimulated by a bounty (Pearson and Verts 1970). After 3 decades of growth, this population has recovered substantially, but the relationship of present numbers to levels during the 1800s and early 1900s is not known.

California

Steller sea lions historically occupied five major rookeries and haulouts in California (San Miquel Island, Año Nuevo Island, the Farallon Islands, Sugarloaf Island/Cape Mendocino, and Saint George Reef) that have been surveyed periodically over the last 75 years. While there is a long, intermittent time series of counts for California (Bonnot 1928, Bonnot and Ripley 1948, Bartholomew and Boolootian 1960, Orr and Poulter 1967, LeBoeuf *et al.* 1991, Westlake *et al.* 1997), standardized counting techniques for state-wide surveys were not implemented until 1996. For this reason some caution is warranted when attempting to evaluate population trend from the older data. Population trends have differed markedly at the major sites; therefore, each site is discussed separately.

Previously, Steller sea lions ranged to the Channel Islands in Southern California, primarily using San Miguel Island but also Santa Rosa Island, which were considered the southernmost rookeries and haulouts (Bonnot 1928, Rowley 1929). It appears that sea lions used these sites seasonally and bred in small numbers (Stewart *et al*. 1993). In the early and middle 20th century, perhaps 2,000 Steller sea lions occupied the Channel Islands (Bonnot and Ripley 1948). Numbers appear to have begun declining about 1938 (Bartholomew 1967), and no adults have been seen there since 1983 and no births recorded since 1982 (Stewart *et al*. 1993). Additionally, several rookery and haulout sites along the California coast, primarily south of Año Nuevo, have been abandoned, as well as a documented rookery at Seal Rocks near San Francisco (Bartholomew and Boolootian 1967, Bonnot 1928, Bonnot and Ripley 1948, Rowley 1929).

Numbers of non-pup Steller sea lions at the two central California sites, Año Nuevo and the Farallon Islands, are currently only about 20% of the levels reported between 1927 and 1964. There appears to have been a particularly steep decline in the 1960s and 1970s. Counts appear to have recently stabilized or at least the rate of decline has lessened (Hastings and Sydeman 2002). Numbers of pups born on Año Nuevo declined from about 600 to 800 during the 1960s (Le Boeuf *et al*. 1991, Orr and Poulter 1967) to 152 in 1999. However, between 1996 and 2004 the number of pups counted stabilized ($P = 0.656$). In 2004, 221 pups were counted at Año Nuevo. Recent pup production on the Farallons has been low (Hastings and Sydeman 2002) with a maximum of 22 pups counted in 2004. During the 1920s, the Farallon Islands and Año Nuevo were identified as the most important rookeries in California (Rowley 1929), with estimates of pup production at 400 and 625, respectively (Bonnot 1928).

Steller sea lions have been counted sporadically at the Sugarloaf/Cape Mendocino rookery and haulout during breeding seasons since 1927. Non-pup numbers appear to have been relatively stable, although highly variable, since 1996. The two highest counts were 900 in 1930 and 740 in 2001 suggesting that the current population is comparable to historical levels. Pups have been counted in recent years and numbers have increased (62 in 1996 to 131 in 2004; +12.9% per year, $R^2 = 0.725$, $P = 0.007$).

The Saint George Reef rookery, located near the California/Oregon border, appears to be at a fairly high level relative to historical measures and counts of non-pups have been stable, although variable, since 1990. During 2004, 444 pups and 738 non-pups were counted at this site. Bonnot (1928) reported 1,500 Steller sea lions at Saint George Reef in 1927 and Bonnot and Ripley (1948) counted 700 animals in 1930. Pups have been counted since 1996 (except for 1997) and have increased (243 in 1996 to 444 in 2004; +9.8% per year, $R^2 = 0.703$, P = 0.009).

Statewide in California, total non-pup counts at these five major rookeries and haulouts during the first half of the last century ranged from 4,500 to 5,600. The 2004 count at these same five sites was 1,578 non-pups and 818 pups suggesting that only about a third as many animals are currently present in the state. Nearly all of the reduction has occurred at the three southern sites. From 1996 through 2004, statewide non-pups numbers were stable, while pup numbers increased at 7.5% per year, $R^2 = 0.679$, P = 0.112).

An additional 1,418 Steller sea lions were counted during the 2002 survey at 41 haulout sites (with counts raging from 1 to 692 animals on these haulouts and with 15 sites with more than 25 animals) along the California coast between Saint George Reef and Año Nuevo Island. Steller sea lion abundance (all age classes) in California, based on 2002 pup counts at rookeries, was 3,209 animals (with the 4.5 pup multiplier) or 3,636 (with the 5.1 pup multiplier). However, 3,815 animals were actually counted during the 2002 survey.

Eastern DPS Overall

Overall, the eastern DPS has increased at over 3% per year since the 1970s, more than doubling in Southeast Alaska, British Columbia, and Oregon (Pitcher et al. 2007). The robustness of the observed positive trend for the eastern population over the past 25-30 years was confirmed by Bayesian trend analyses conducted by Goodman (see Appendix 3 in NMFS 2008). He estimated annual growth at 3.64% for nonpups in Oregon with a 95% confidence interval of 2.42 to 4.44% and concluded that there was an extremely low probability (0.01) that the actual growth rate was lower than 2% per year. For pups in Southeast Alaska he estimated annual growth at 3.13% (95% confidence interval of 2.29 to 3.95%). The probability of a growth rate below 1.5% per year was estimated at 0.1% for the Southeast counts.

Saint George Reef rookery and Sugarloaf rookery in northern California are near levels recorded early in the 20th century, and pup production has increased since 1996. This increase is probably at least partially the result of protective legislation, enacted in both the United States and Canada during the early 1970s, that reduced mortality at a time when the population was below carrying capacity. However, numbers of animals at the Año Nuevo rookery and the Farallon Islands in central California are substantially reduced (-90%) from those reported early in the 20th century (Bonnot 1928), despite legal protection from directed human take. The former haulout/rookery at San Miguel Island is now extinct, as are several other sites previously used in California (Rowley 1929). The reason for the large declines, since the mid-1900s, in southern and central California are not known. However, sympatric populations of other pinnipeds have grown greatly over the past 75 years (Stewart *et al.* 1993). In particular, a closely related species, the California sea lion (*Zalophus californianus*), has increased greatly from at most a few thousand in the 1920s (Bonnot 1928) to between 237,000 and 244,000 in 2004 (Carretta *et al*. 2005); some aspect of a competitive relationship may have been involved in the Steller sea lion decline in this subarea (?). Changes in the ocean environment, particularly warmer water temperatures, have also been proposed as possible factors that favored California sea lions and other pinnipeds over Steller sea lions through changes in the distribution of favored prey (Bartholomew and Boolootian 1960).

The eastern population was subjected to substantial mortality by humans, primarily due to commercial exploitation and both sanctioned and unsanctioned predator control, (Bonnot 1928, Scheffer 1946, Rowley 1929, Bonnot and Ripley 1948, Pearson and Verts 1970, Bigg 1988, Scheffer 1950). Commercial exploitation occurred primarily in the 1800s and early 1900s while unsanctioned predator control probably persisted into the 1970s in some locations. Although not well documented, there is little doubt that numbers of Steller sea lions were greatly reduced in many locations.

Within the eastern DPS, 13 rookeries and about 85 major haulout sites currently exist from Cape Fairweather (58.8°N, 137.9°W) to Año Nuevo Island (37.1°N, 122.3°W). Populations associated with 12 of these rookeries have either increased or stabilized at relatively high levels in recent years. Total population size of the eastern DPS in 2002 was estimated to range between 45,000 and 51,000 animals of all ages. Additional surveys in California during 2003 and 2004 and in Southeast Alaska during 2005 suggest the eastern DPS has continued to increase since the 2002 survey and likely exceeds 50,000 animals.

Conditions for Steller sea lions in the eastern DPS appear to be most favorable in the northern portion of their range. Southeast Alaska and British Columbia together account for nearly 82% of total pup production. All four rookeries founded in the past 25 years are located in northern Southeast Alaska at the northern extent of the population range. The southernmost portion of the range has contracted and the southernmost active rookery, at Año Nuevo Island, appears to have stabilized at a low population size. A somewhat similar change in Steller sea lion distribution and the establishment of new breeding sites have been noted along the Asian coast, where the southern range limit moved northward by 500-900 km over the past 50 years and several new rookeries were established (Burkanov and Loughlin *in press*).

Currently, no Steller sea lion rookeries exist within a geographical gap (993 km) between the Scott Islands Rookery off northwest Vancouver Island and Orford and Rogue Reef Rookeries in southern Oregon. It is possible that additional rookeries were once located along this coastline, and it would not be surprising to see new rookeries founded or re-established, as has occurred in Southeast Alaska, if the population continues to increase. Steller sea lion rookeries are normally located on remote, offshore islands or reefs and require adequate areas above high water levels where young pups can survive most weather conditions and adequate prey is available on a consistent basis within the foraging range of lactating females. Perhaps the limited availability of such sites has prevented the establishment of additional new rookeries.

During the 1970s the eastern DPS contained only about 10% of the total number of Steller sea lions in the U.S. The large decline in the western DPS in conjunction with the increase in the east has changed the proportional distribution dramatically with over half of U.S. Steller sea lions now belonging to the eastern DPS.

3.1.5 Vital Rates

Changes in the size of a population are ultimately due to changes in one or more of its vital demographic rates. Inputs to the population are provided by reproduction of adults (e.g., birth rates, natality, fecundity; probability that a female of a given age will give birth to a pup each year) and immigration. Outputs from the population include those that leave the population through emigration or death, which can also be inversely described by rates of adult and juvenile survivorship. Estimates of vital rates are best determined in longitudinal studies of marked animals, but can also be estimated through population models fit to time series of counts of sea lions at different ages or stages (e.g., pups, non-pups).

3.1.5.1 Survival

Causes of pup mortality include drowning, starvation caused by separation from the mother, disease, parasitism, predation, crushing by larger animals, biting by other sea lions, and complications during parturition (Orr and Poulter 1967, Edie 1977, Maniscalco *et al.* 2002, 2006 ADF&G and NMFS unpublished data). Older animals may die from starvation, injuries, disease, predation, subsistence harvests, intentional shooting by humans, entanglement in marine debris, and fishery interactions (Merrick *et al*. 1987).

Calkins and Pitcher (1982) estimated mortality rates using life tables constructed from samples collected in the Gulf of Alaska in 1975-1978. The estimated overall mortality from birth to age 3 was 0.53 for females and 0.74 for males; i.e., 47% of females and 26% of males survived the first 3 years of life. Annual mortality rate decreased from 0.132 for females 3-4 years of age, to 0.121 for females 4-5 years old, to 0.112 for females 5-6 years old, and to 0.11 by the seventh year; it remained at about that level in older age classes. Male mortality rates decreased from 0.14 in the third year to 0.12 in the fifth year. Females may live to 30 years and males to about 20 (Calkins and Pitcher 1982).

York (1994) produced a revised life table for female Steller sea lions using the same data as Calkins and Pitcher (1982) but a different model. The estimated annual mortality from York's life table was 0.22 for ages 0-2, dropping to 0.07 at age 3, and then increasing gradually to 0.15 by age 10 and 0.20 by age 20. Population modeling suggested that decreased juvenile survival likely played a major role in the decline of sea lions in the central Gulf of Alaska during 1975-1985 (Pascual and Adkison 1994, York 1994, Holmes and York 2003). This is supported by field observations on two major rookeries in the western DPS. The proportion of juvenile sea lions counted at Ugamak Island was much lower in 1985 and 1986 than during the 1970s, suggesting that the mortality of pups/juveniles increased between the two periods (Merrick *et al*. 1988). A decline in the proportion of juvenile animals also occurred at Marmot Island during the period 1979-1994. A very low resighting rate for pups marked at Marmot Island in 1987 and 1988 suggested that the change in proportions of age classes was due to a high rate of juvenile mortality (Chumbley *et al*. 1997; Pendleton et al. 2006).

Holmes and York (2003) and Holmes *et al.* (2007) modeled Steller sea lion pup and non-pup population trends in the CGOA and concluded that both juvenile and adult survivorship had increased since the 1980s. This conclusion is consistent with preliminary analyses from the current (since 2000) branding program which also indicates increases in survival rates at numerous sites compared to survival rates observed in the late 1980s at Marmot Island (NMFS 2006b; Pendleton et al. 2006; Fritz et al. 2008b). Fay and Punt (2006) also concluded that survival had increased from the 1980s but that reproductive rates had likely declined.

3.1.5.2 Reproduction and Growth

Steller sea lions have a polygynous reproductive system in which a single male may mate with multiple females. Males establish territories in May in anticipation of female arrival (Pitcher and Calkins 1981). Mating occurs on land (or in the surf or intertidal zones), thus males are able to defend territories and thereby exert at least partial control over access to adult females and mating privileges. The pupping and mating season is relatively short and synchronous, probably due to the strong seasonality of the environment and the need to balance aggregation for reproductive purposes with dispersion to take advantage of distant food resources (Bartholomew 1970). In late May and early June, adult females arrive at the rookeries, where pregnant females give birth to a single pup (twinning is rare). Viable births begin in late May and continue through early July. The sex ratio of pups at birth is approximately 1:1, though biased toward slightly greater production of males (e.g., Pike and Maxwell 1958, Lowry *et al.* 1982, NMFS 1992b). Pupping occurs throughout the sea lion range between the Aleutian Islands and California, with a median pupping date of 12-13 June (Bigg 1985, Merrick 1987). Pupping tends to be synchronous within individual rookeries with 90% of pups born within a 25-day period (Pitcher *et al.* 2001). Pitcher *et al.* (2001) found the earliest mean pupping dates at Forrester Island (southeast Alaska) and the latest mean pupping dates at Ano Nuevo Island (California). Mean date of birth became progressively later both north and south of Forrester Island. They hypothesized that timing of births at rookeries is determined through selection of periods when weather conditions are generally favorable for pup survival and when adequate prey are predictably available near rookeries for lactating females. The most likely explanation for temporal variability at individual rookeries is variable nutritional status of reproductive females (Pitcher *et al.* 2001).

Historically, birth rates were estimated from the examination of reproductive tracts from animals that were killed for scientific study. Detailed information on Steller sea lion reproduction historically was obtained from examinations of reproductive tracts of dead animals. These studies have shown that female Steller sea lions reach sexual maturity at 3-6 years of age and may produce young into their early 20s (Mathisen *et al.* 1962, Pitcher and Calkins 1981). The average age of reproducing females (i.e., generation time) is about 10 years based on the life tables from Calkins and Pitcher (1982) and York (1994). Adult females normally ovulate once each year, and most breed annually (Pitcher and Calkins 1981) although because of a high rate of reproductive failures, estimated birth rates have ranged from 55% to 63% (Calkins and Goodwin 1988, Pitcher and Calkins 1981, Pitcher *et al.* 1998). Females give birth to a single pup from late May through early July and then breed about 11 days after giving birth. They undergo delayed implantation and the blastocyst implants about 3.5 months after breeding. Some offspring are weaned near their first birthday while others continue suckling for an additional year or more. Males are territorial during the breeding season, and one male may breed with several females. Thorsteinson and Lensink (1962) found that 90% of males holding territories on rookeries in the western Gulf of Alaska were between 9 and 13 years of age, while Raum-Suryan *et al.* (2002) found that males marked on Marmot Island as pups first became territorial at 10 and 11 years of age.

One of the key parameters governing population growth is reproductive output (birth rate). Reproductive output may be affected by nutrition, diseases, contaminants, and other factors (Merrick *et al.* 1987, Pitcher *et al.* 1998).

In samples collected in the Gulf of Alaska in the mid-1980s, Calkins and Goodwin (1988) found that 97% of females aged 6 years and older had ovulated. Ninety-two percent of females 7-20 years old were pregnant when they were collected in October during early implantation. The pregnancy rate of sexually mature females collected during April-May (late gestation) was only 60%, indicating that a considerable amount of intrauterine mortality and/or premature births occurred after implantation. Estimates of near-term pregnancy rates of all adult females were 67% from a collection of females taken from 1975-1978 and 55% from a similar collection during the mid-1980s (Pitcher *et al.* 1998), the difference was not statistically significant between periods (P = 0.34), yet the statistical power to detect the difference was less than 0.50. However, the difference in pregnancy rates of the lactating females between the 1970s (63%) and 1980s (30%) was significant (P = 0.059). Better body condition was found to increase the probability that a female would maintain pregnancy. Comparatively low birth rates for females from the western DPS during the 1970s and 1980s (Pitcher and Calkins 1981) coupled with elevated embryonic and fetal mortality appear to have contributed to decreased reproductive performance during the period of early decline (Pitcher and Calkins 1981, Calkins and Goodwin 1988, Pitcher *et al.* 1998, NMFS 1998a, 1998b, 2000).

Examination of reproductive tracts from female Steller sea lions killed in January and February near Hokkaido, Japan in 1995-96 showed that the pregnancy rate for females that had ovulated was 88% (23/26) (Ishinazaka and Endo 1999). This estimated pregnancy rate was much higher compared to the late-term rates of 55-67% estimated for sea lions from Alaska.

Age-structured models fit to observed time series of pup and non-pup counts suggest that declines in reproductive performance of females in the western DPS continued into the 1990s in some or major parts of the Alaskan range (Holmes and York 2003, Fay 2004, Fay and Punt 2006; Holmes et al. 2007), but may have increased in the late 1990s and 2000s in most areas (Winship and Trites 2006). Holmes *et al.* (2007) make a strong case that at least in the central GOA, natality rates have continued to decline in the 1990s and 2000s from pre-decline levels. The results from the published modeling studies related to continued declines in natality were questioned in an unpublished report released to the NPFMC and posted on the ASLC website (Maniscalco et al. 2009). This report, which was based on rates of reproduction observed during a longitudinal study of the marked females at the Chiswell Islands, was subsequently reviewed by the AFSC at the request of the Alaska Region (memo from D. DeMaster to D. Mecum 2009 and attached reviews). These reviews raised serious issues related to key assumptions and methods used in the Maniscalco report. As the issue of the most scientifically defensible analysis and interpretation of the data from the Chiswell longitudinal reproduction study is not yet resolved or even being debated in the peer review literature, we do not consider statements based on the data from this study further.

Declines in female reproductive performance may have been, and may still be, linked to body condition and/or growth. Steller sea lions collected in the Gulf of Alaska during the early 1980s showed evidence of reproductive failure and reduced rates of body growth that were consistent with nutritional stress (Calkins and Goodwin 1988, Pitcher *et al.* 1998, Calkins *et al.* 1998). Lactating females were less likely to become pregnant than non-lactating females during the early decline, indicating that the energetic stress of nursing while being pregnant with another pup may have prevented some females from giving birth each year (Pitcher *et al.* 1998). Better body condition was correlated with a higher likelihood that a female would maintain pregnancy. Comparatively low birth rates for females from the western DPS during the 1970s and 1980s (Pitcher and Calkins 1981) coupled with elevated embryonic and fetal mortality appear to have contributed to decreased reproductive performance during the period of early decline (Pitcher and Calkins 1981, Calkins and Goodwin 1988, Pitcher *et al.* 1998, NMFS 1998a, 1998b, 2000).

It is important to obtain current estimates of birth rate since the most recent estimates are from 1985-86. Estimates will need to be derived from alternative techniques such as mark-resight estimation, analysis of reproductive hormone levels in feces or tissue samples, or population modeling.

Merrick *et al.* (1995) compared pup sizes at different sites where Steller sea lion populations were either decreasing or increasing, to determine if decreased pup size or growth was correlated with decreasing population trend. Their results were not consistent with this hypothesis; rather, they found that pups about two to four weeks of age weighed more at western, declining rookeries in the Aleutian Islands and GOA than at eastern, stable or increasing rookeries in southeast Alaska or Oregon. While western DPS 2-4 week-old pups weighed more than those in the eastern DPS, they were not disproportionately heavy for their length (Fadely and Loughlin 2001). These size differences may arise through different growth rates, as no significant differences have been found among neonatal mass among rookeries (Brandon and Davis 1999, Adams 2000). Brandon and Davis (1999) and Adams (2000) found that pups at rookeries in areas of decline grew faster than pups from southeast Alaska. As there were no differences in milk or energy intake among pups at these rookeries, differences in growth rates may be attributable to differences in pup activity (Adams, 2000), time spent fasting between suckling bouts, or other physiological costs (Brandon *et al.* 2005). These observed differences indicate that at least this phase of reproduction may not be affected by whatever factors are limiting natality; that is, if females are able to complete their pregnancy and give birth, then the size of those pups does not appear to be compromised (Davis *et al.* 2006). Possible alternative explanations for the observed size differences are that pups were measured at different ages (i.e., pups in the GOA and Aleutian Islands may have been born earlier and therefore were older when weighed), or that over time, harsher environmental conditions in the Aleutian Islands of the GOA have selected for larger pup size. Pup condition, measured as the ratio of observed body mass to that expected based on length, seems to be a reasonable index of condition related to survival (Trites and Jonker 2000). For the pups aged between 2 and 4 weeks, there was no general relationship between pup condition and pup numbers or magnitude of decline at rookeries, though the poorest average pup conditions during the late 1990s were associated with areas of greatest decline (Fadely and Loughlin

2001). There also was evidence that pup condition was poorest during weak depressions of the Aleutian Low, and better when the Aleutian Low was stronger.

Mothers nurse pups during the day, staying with a pup for the first week, then go to sea on foraging trips. Maternal attendance patterns seem to vary over the range, with the average length of foraging trips during lactation being about 24 hours to two days at the southernmost rookery at Año Nuevo Island, California (Higgins *et al.* 1988, Hood and Ono 1997), about 25 hours at Lowrie Island, 19 hours at Fish Island, 11 hours for Chirikof Island, and 7 hours in the Aleutian Islands (Brandon and Davis 1999, Davis *et al.* 2006). Trites et al. 2005 compared observations of females at sites in both the Eastern and Western stock and found no difference in foraging bout lengths between the two populations. Also, Davis *et al.* (2006) found no evidence (based on pup size, growth rate, or female trip duration) that female sea lions or pups in the western DPS were nutritionally stressed the first 6 weeks postpartum.

The length of the nursing period may be an important indicator of the female's condition and ability to support her pup, and the pup's condition at weaning (and hence, the likelihood that the pup will survive the post weaning period). Steller sea lion weaning takes place away from the rookeries, over a period of time, and has only rarely been reported in Alaska (Trites et al. 2005). Thorsteinson and Lensink (1962) suggested that nursing of yearlings was common at Marmot Island in 1959. Pitcher and Calkins (1981) suggested that it is more common for pups to be weaned before the end of their first year, but they also observed nursing juveniles (aged 1 to 3). Porter (1997) distinguished metabolic weaning (i.e., the end of nutritional dependence of the pup or juvenile on the mother) from behavioral weaning (i.e., the point at which the pup or juvenile no longer maintains a behavioral attachment to the mother). He also suggested that metabolic weaning is more likely a gradual process occurring over time and more likely to occur in March-April, preceding the next reproductive season. In many otariids, the length of the lactation period varies among individuals and 'weaning' occurs over a period of time, rather than at a single point of time as with phocids (Lee *et al.* 1991). Using an allometric relationship between weaning mass and maternal mass for otariids (Kovacs and Lavigne 1992), and assuming a maternal mass of 530 lbs (240 kg) (midpoint of range of maternal masses, 386.8 - 663 lbs (175 - 300 kg) (Calkins and Pitcher 1982), Steller sea lions could be expected to wean when achieving a body mass of 159 - 183 lbs (72 - 83 kg). According to growth data of Calkins and Pitcher (1982), this is achieved at an age of 11 months, and assuming a median pupping date of June 12, is an age reached in mid-May. A weaning age of 11 months was also used in analyses of comparative mammalian weaning by Lee *et al.* (1991).

The transition to nutritional independence may, therefore, occur over a period of months as the pup begins to develop essential foraging skills, and depends less and less on the adult female. The length of the nursing period may also vary as a function of the condition of the adult female. The nature and timing of weaning is important because it determines the resources available to the pup during the more demanding winter season and, conversely, the demands placed on the mother during the same period. A bioenergetic model suggested that a 10 year old female nursing a pup in the spring had to consume twice as much energy as a same age female without a pup (Winship 2000). The maintenance of the mother-offspring bond may also limit their distribution or the area used for foraging.

Recent studies of weaning suggest that pups don't always wean before the next breeding season however. York et al. 2008 used stable isotope ratios in the teeth of 113 female sea lions born between 1960 and 1983 to examine changes in the age of weaning. They found that except for the period of the regime shift of 1975-1976 the age of weaning increased over time. Overall, approximately 60% of the females weaned in their first year, 30% in their second year and 8% in their third year. Similarly, Trites et al. used observations of nursing pups and yearlings to argue that in southeast Alaska about one half of the female pups weaned in their second year and "most" male pups weaned in their second year. In a study using satellite telemetry to compare foraging bout behavior between the eastern and western stock, Call et al. (2007) used significant increases in time spent at sea to suggest decreases in maternal independence. They found that this apparent change occurred approximately 10 months later in individuals from Prince William Sound (western stock) and Southeast Alaska (eastern stock) than in the Aleutian Islands and Central Gulf of Alaska. Additional work is necessary to determine the average weaning ages of pups currently born in the western stock.

Relatively little is known about the life history of sea lions during the juvenile years between weaning and maturity. Female growth is asymptotic, and reaches 87% of the asymptote during their third year (Winship *et al.* 2001), a size typically associated with puberty in female pinnipeds (Laws, 1956). Pitcher and Calkins (1981) found that females reach sexual maturity between 2-8 years of age, with an average age of first pregnancy at 4.9 ±1.2 years, and may breed into their early twenties. The available literature indicates an overall reproductive (birth) rate on the order of 55% - 70% or greater (Pike and Maxwell 1958, Gentry 1970, Pitcher and Calkins 1981, York (1994) derived age-specific fecundity rates based on data from Calkins and Pitcher (1982). Those rates illustrate a number of important points and assumptions. First, the probability of pupping is rare (about 10%) for animals 4 years of age or younger. Second, maturation of 100% of a cohort of females occurs over a prolonged period which may be as long as 4 years (starting at age 3 or 4). Third, the reported constancy of fecundity extending from age 6 to 30 indicates that either senescence has no effect on fecundity, or our information on fecundity rates is not sufficiently detailed to allow confident estimation of age-specific rates for animals older than age 6. Given the small size of the sample taken, the latter is a more likely explanation for such an assumption. Holmes *et al.* (2007) reanalyzed the Calkins and Pitcher (1982) pregnancy data and included reproductive senescence in their life table of the 1970s central Gulf of Alaska Steller sea lion population.

For mature females, the reproductive cycle includes mating, gestation, parturition, and nursing or post- natal care. Mating occurs about one to 2 weeks after giving birth (Gentry 1970). Copulation may occur in the water, but mostly occurs on land (Pitcher and Calkins 1998, Gentry 1970, Gisiner 1985). The gestation period is probably about 50 to 51 weeks, but implantation of the blastocyst is delayed until late September or early October (Pitcher and Calkins 1981). Due to delayed implantation, the metabolic demands of a developing fetus are not imposed on the female until well into fall and winter (Winship and Trites 2003). After parturition (birth), females nurse their pups over a period of months to several years. The reproductive success of an adult female is determined by a number of factors within a cycle and over time through multiple cycles. The adult female's ability to complete this cycle successfully is largely dependent on the resources available to her. While much of the effort to explain the Steller sea lion decline has focused on juvenile survival rates, considerable evidence suggests that decreased reproductive success may also have contributed to the decline.

- Holmes et al (2007), using an age-structured model of the Steller sea lion population in the central Gulf of Alaska (fit to time series of counts of pups, non-pups at trend sites, and estimates of the juvenile fraction of the population), estimated that birth rates in the period 1998-2004 had declined 36% from birth rates estimated in the mid-1970s (York 1994; Holmes and York 2003).
- Young females collected in the 1970s were larger than females of the same age collected in the 1980s (Calkins *et al.* 1998). As size, as well as age, may influence the onset of maturity, females in the 1980s would also be more likely to mature and begin to contribute to population productivity at a later age.
- Pitcher *et al.* (1998) provide data from the 1970s and 1980s that suggest a high pregnancy rate after the mating season (97%; both periods), which declined to 67% for females collected in the 1970s, 55% for females collected in the 1980s. These changes in pregnancy rate suggest a high rate of fetal mortality that could be a common feature of the Steller sea lion reproductive strategy (i.e., may occur even when conditions are favorable and population growth is occurring), but could also be an indication of stress (possibly nutritional) experienced by individual females.
- ▪ The observed differences in late pregnancy rates (67% in the 1970s and 55% in the 1980s) were not statistically significant. However, the direction of the difference is consistent with the hypothesis that reproductive effort in the 1980s was compromised.
- ▪ Pitcher *et al.* (1998) did observe a statistical difference in the late season pregnancy rates of lactating females in the 1970s (63%) versus lactating females (those who still had a dependent pup) in the 1980s (30%). This difference indicates that in contrast to lactating females in the 1970s, lactating females in the 1980s were less able to support a fetus and successfully complete consecutive pregnancies.

Male growth is also asymptotic, but constant until about year 6 and thus males grow at a greater rate for a longer period than do females (Winship *et al.* 2001). Males also reach sexual maturity at about 3 - 8 years old, but do not have the physical size or skill to obtain and keep a breeding territory until they are nine years of age or older (Pitcher and Calkins 1981). A sample of 185 territorial males from Marmot, Atkins, Ugamak, Jude, and Chowiet Islands in 1959 included animals 6 - 17 years of age, with 90% from 9 - 13 years old (Thorsteinson and Lensink 1962). Males may return to the same territory for up to 7 years, but most return for no more than 3 years (Gisiner 1985). During the breeding season, males may not eat for 1 to 2 months. The rigors of fighting to obtain and hold a territory and the physiological stress of the mating season reduces their life expectancy. Males rarely live beyond their mid-teens, while females may live as long as 30 years.

3.1.5.3 Demographic Modeling

Demographic analysis of age distribution information has been used to estimate demographic rates in an attempt to identify the combination of changes in birth and survival rates that might account for the observed past changes in pup and non-pup numbers across the range of the western DPS in Alaska. These analyses are hampered by sparseness and spottiness of data.

There are essentially only two collections of western Steller sea lions that were large enough and well-sampled (e.g., age, past and present reproductive status, food habits, condition, blood chemistry) to be useful in modeling studies: one collected in the mid 1970s (Calkins and Pitcher 1982) and another in the mid 1980s (Calkins and Goodwin 1988). Both samples, however, were collected largely within the Kodiak archipelago, and the 1980s collection was biased toward adult females. York (1994) created a life table estimate from the 1970s collection by assuming (1) that this collection was representative of age distributions and reproductive frequencies in the entire population, (2) that the population was in stable age distribution, and (3) that there was no population growth.

At a much less detailed level, some censusing techniques distinguish between pups and non-pups in the counts at many rookeries. There are over 30 rookeries that have been censused over the years in a regular, but much less frequent than annual, rotation. If assumptions are made about the tendency of non-breeding animals of breeding age, as well as animals of below breeding age, to be present on rookeries and be included in the counts (this is not actually known yet, and is a matter of ongoing investigation in the analysis of sighting records of branded animals), the time series of counts of pups and non-pups allow some inference about crude per capita birth rates to adults, crude per capita survival rates of the adults, and rates of survival from birth until recruitment to the breeding segment of the population.

York (1994) concluded from her life table analysis that the population decline observed in the 1980s at Marmot likely was primarily owing to a large drop in juvenile survivorship compared to the 1970s, a conclusion also reached by Pascual and Adkison (1994). Holmes and York (2003) and Holmes et al (2007) extended these analyses of central Gulf of Alaska sea lions through 2004 and added an index of juvenile recruitment to the model. Their results, along with those of Fay (2004) and Fay and Punt (2006), indicated a drop in juvenile survivorship from the 1970s to the 1980s, and that the slower decline rate in the 1990s was associated with increases in juvenile and adult survivorship compared to the 1980s. However, their analyses also showed an erosion in fecundity (birth rates plus pup mortality through 1 month) that began in the late 1970s and early 1980s (Holmes and York 2003) and continued through 2004 (Holmes et al. 2007).

Fay (2004) and Winship and Trites (2006) broadened the geographic scope by estimating time series of vital rates for metapopulations, or at each rookery in the Gulf of Alaska and Aleutian Islands, from 1978-2002. Results of these studies suggest that the changes in vital rates responsible for the declines likely varied among subpopulations and with time. Juvenile and adult survival rates appear to have been lowest during the 1980s for many, but not all subpopulations, while juvenile survival in the western Aleutians appears to have been lower during the 1990s than during the 1980s. With regard to changes in fecundity, Fay (2004) found evidence of DPS-wide declines in birth rates beginning in the early 1980s with little or no rebound through 2000. Winship and Trites (2006) found declines in fecundity in the central Gulf of Alaska (similar to Holmes and York 2003, Fay 2004 Holmes et al. 2007), but not elsewhere in the range of the western DPS.

The studies attempting to estimate past demographic rates were motivated in part by a hope that these could shed light on the various possible causes for the changes in vital rates responsible for the population decline. In this, the retrospective studies have been largely inconclusive. One exception is the study by Hennen (2006) which found an association between rate of by-rookery decline and the fishing activity around the respective rookies, for the period of the 1980s but not continuing into the 1990s. Hennen (2006) did not investigate how this effect might have been partitioned among birth rates and survival rates of various age classes.

Population Viability and Extinction Risk

Population viability analysis (PVA) attempts to predict the probability of a population going extinct, or crossing a specified threshold, over a specified period. Four simulation models of varying complexity have been constructed to assess the likelihood that Steller sea lions will go extinct in western Alaska (York *et al.* 1996, Gerber and VanBlaricom 2001, Winship and Trites 2006, NMFS 2006[7]). Some of the models treated each rookery as independent populations, while others considered metapopulations (i.e., groups of rookeries), or combined counts from all rookeries between the eastern Gulf of Alaska and the western tip of the Aleutian Islands into a single population estimate.

The rookery-based and metapopulation modeling requires assumptions about rates of migration and recolonization. Those rates are not presently known, though they are the subject of ongoing monitoring of branded animals. Each of the models used information about rates of population change that occurred in the past to infer what might happen to sea lion populations in the future.

York *et al.* (1996) developed three models corresponding to three spatial scales (a rookery model, a cluster of rookeries model, and an aggregate model for the Kenai – Kiska area). They used a model of exponential growth randomly changing annually from a distribution that remains constant over time to model counts of adult female sea lions made at the peak of the breeding season. Using counts from 1976-1994 in their retrospective analysis, the rookery model predicted that the median number of adult females on each rookery between Kenai-Kiska would decline to fewer than 50 animals with 80% of the rookeries disappearing within 100 years, and fewer than 5,000 females remaining by 2015. However, some sites (Akutan, Clubbing Rocks, Ugamak Island, Sea Lion Rocks, and Akun Island) were predicted to persist beyond 100 years despite extinctions at other rookeries. The cluster model grouped Steller sea lion rookeries into 5 clusters and found a relatively high probability of persistence of the western DPS due to positive growth rates in the western Gulf of Alaska cluster. However, pooling all rookery counts within the Kenai – Kiska area to form a single breeding population, and using the rates of decline that occurred from 1976-1994 to project the future, resulted in a predictable continued decline of the western DPS. York *et al.* (1996) concluded that there was no indication that the entire population would likely go extinct within 30 years, but that populations on some rookeries would probably be reduced to low levels (fewer than 200 adult females). The rookery-based model predicted the longest mean persistence time for the Kenai-

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[7] The PVA in NMFS (2006; in Appendix 3) was developed by Dr. Dan Goodman in coordination with the Steller Sea Lion Recovery Team and was funded by NMFS in order to facilitate the development of recovery criteria for the recovery plan. Further citations to NMFS (2006) in the discussion of PVA recognize the work of Dr. Goodman and the recovery team.

Kiska population, while the geographic model (pooling all rookery counts) predicted the shortest.

Gerber and VanBlaricom (2001) used count data from 1965-1997 to develop two viability models that evaluated the sensitivity of extinction risk to various levels of stochasticity, spatial scale, and density dependence, again assuming annual variation was the predominant process driver. The first was a metapopulation simulation model that suggested a median time to extinction of about 85 years based on the dynamics of groups of rookeries in the Central Gulf of Alaska, Western Gulf of Alaska, Eastern Aleutian Islands, and the Central Aleutian Islands. The second model was exploratory rather than tied strictly to the retrospective analysis and considered population size and population growth rates corresponding to the lowest 5% of the frequency distribution of likely growth rates. This model suggested the time to extinction was about 62 years. Gerber and VanBlaricom (2001) concluded that results from their analysis were consistent with a population threatened with extinction.

Winship and Trites (2006) used counts of both pups and non-pups from 33 rookeries between 1978 and 2002 to estimate the combination of birth and survival rates operating during the population decline. They then projected each of the 33 rookery populations into the future using these estimated site-specific life tables (with associated uncertainties). Using Bayesian statistical methods to quantify uncertainty, Winship and Trites (2006) explored 3 scenarios that incorporated different assumptions about carrying capacities and the presence or absence of density-dependent regulation. Results of all 3 scenarios indicated an overall low risk of extirpation of Steller sea lions as a species in western Alaska in the next 100 years. However, most rookeries had high probabilities of going extinct if trends observed in the 1990s continued — while fewer were predicted to go extinct if trends observed since the late 1990s persisted. All simulations identified two clusters of contiguous rookeries that had relatively low risks of extinction if their dynamics continued to be independent of the rest— the Unimak Pass area in the western Gulf of Alaska / eastern Aleutian Islands, and the Seguam – Adak region in the central Aleutian Islands. Risks of rookeries going extinct were particularly small when density-dependent compensation in birth and survival rates was assumed. Winship and Trites (2006) did not include the more drastic decline rates from the 1980s in their analysis, thereby treating this time period as a catastrophic event which was unlikely to occur again. They did not provide a rationale for this approach in their paper; yet it is a major distinction between each of the PVAs discussed here and available for consideration[8].

The report written by Dan Goodman and commissioned by NMFS (2008) to be used by the Steller sea lion Recovery Team used a Bayesian framework to quantify uncertainty in model parameters and propagate this through the risk calculation. However, Goodman treated the western Steller sea lions as a single population by combining counts made at all rookeries and regions of western Alaska, and treated the dominant environmental variation as occurring on a larger than annual time scale. Such population-wide estimates were available for 6 years over

8Winship and Trites (2006) state: "We modeled the historic decline as a catastrophe, but did not model any future catastrophes. If another catastrophe occurred in the time frame of our future simulations (100 yr), the predicted risks of extinction would have been higher than those we estimated."

the 46 years that sea lions have been counted (i.e., 1958, 1977, 1985, 1989, 2000 and 2004). In this analysis the probability of sea lions persisting for 100 to 500 years depended upon assumptions about the past operation of anthropogenic factors that will not play such a large role in the future. These specific assumptions were a joint product of a subgroup of the recovery team. Overall, this model suggested significant probabilities of sea lions declining below a threshold of 4,743 individuals (i.e., quasi-extinction) for the population as a whole within 100 years. This model allows a parsing of how unfavorable parameter values and uncertainty about parameter values both play a role in the calculated risk.

There is some degree of consistency between the predictions of all four sets of PVA models (York *et al.* 1996, Gerber and VanBlaricom 2001, Winship and Trites 2006, NMFS 2008) due in large part to their use of some of the same base population data and to the fundamental assumption of all PVA models that populations will continue to behave as they have in the past after correction for factors that will be different in the future. As such, sea lion populations (i.e., individual rookeries, clusters of rookeries, or the entire western DPS) that declined at fast rates were predicted to go extinct sooner than populations that had declined slowly. Results from the four PVAs conducted to date indicate that the western Steller sea lions have a high probability of declining to a low level if they are considered as a single homogeneous population (by combining all rookery counts and assuming an overarching population trend). However, the prognosis for the species is considerably more optimistic if each of the 33 rookeries is considered as distinct, independent populations with its own probability of persistence, and assuming that differing environmental factors around the respective rookeries remain stationary for the long term (as opposed to the possibility of rolling declines). Under this scenario, PVA models at a spatial scale smaller than the DPS predict that many rookeries will go extinct, but that the species will persist on the time frame considered, most especially if assumed density dependence plays a positive role.

The large potential influence of assumed density dependence is a common feature in the literature of PVA applications, but the statistical estimation of the strength of operation of density dependence in any particular population is notoriously problematic. Density dependence has not been established empirically in the dynamics observed in the Steller sea lion western DPS over the past 40 years.

3.1.6 Terrestrial Habitat Use

Steller sea lions use a variety of marine and terrestrial habitats. Haulouts and rookeries tend to be preferentially located on exposed rocky shoreline and wave-cut platforms (Ban and Trites 2007, Call and Loughlin 2005). Some rookeries and haulouts are also located on gravel beaches. Rookeries are nearly exclusively located on offshore islands and reefs. Terrestrial sites used by Steller sea lions tend to be associated with waters that are relatively shallow and well-mixed, with average tidal speeds and gradual bottom slopes (Ban and Trites 2007). When not on land, Steller sea lions are seen near shore and out to the edge of the continental shelf and beyond.

Female sea lions appear to select places for giving birth that are gently sloping and protected from waves (Sandegren 1970, Edie 1977). Pups normally stay on land for about two weeks, and then spend an increasing amount of time in intertidal areas and swimming near shore. Mothers spend more time foraging as pups grow older and less time on shore nursing (Milette and Trites 2003). Females with pups begin dispersing from rookeries to haulouts when the pups are about 2.5 months-of-age (Raum-Suryan *et al*. 2004, Maniscalco *et al.* 2002, 2006).

Haulout is the term used to describe terrestrial areas used by adult sea lions during times other than the breeding season and by non-breeding adults and subadults throughout the year. Sites used as rookeries in the breeding season may also be used as haulouts during other times of year. Some haulouts are used year-around while others only on a seasonal basis. Sea lions are sometimes seen hauled out on jetties and breakwaters, navigational aids, floating docks, and sea ice. Many animals also use traditional rafting sites, which are places where they rest on the ocean surface in a tightly packed group (Bigg 1985, NMFS unpublished data).

Although rookeries and haulouts occur in many types of areas, sea lions display strong site fidelity to specific locations from year to year. Factors that influence the suitability of a particular area may include substrate, exposure, proximity to food resources, oceanographic conditions, tradition of use, and season (Calkins and Pitcher 1982, Ban 2005), as well as the extent and type of human activities in the region (Johnson *et al*. 1989). Thermoregulatory factors may play an important role in site selection (Gentry 1970, Sandegren 1970).

Womble et al. (2009) undertook studies (2001-2004) to classify seasonal distribution patterns of Steller sea lions in Southeast Alaska and to determine to what extent the seasonal distribution of Steller sea lions is explained by seasonal concentrations of prey. Using aerial surveys, these researchers counted sea lions of all age classes monthly at 28 terrestrial sites. Statistical analysis revealed four distinct seasonal distributional patterns which were "commonly associated with the seasonal availability of prey…near the terrestrial sites." (Womble et al. 2009: . In the winter (December) 55% of the sea lions in the study area were at terrestrial sites near over-wintering herring aggregations whereas in May approximately this same percentage (56%) were at sites near forage fish spawning aggregations. In July, 78% of the sea lions in the study area were found at terrestrial sites near summer migratory corridors of salmon, whereas in September, 44% of sea lions were at sites near autumn migratory corridors of salmon. Womble et al. (2009:) concluded that: "A reasonable annual foraging strategy for Steller sea lions is to forage on herring...aggregations in winter, spawning aggregations of forage fish in spring, salmon…in summer and autumn, and pollock…and Pacific hake…throughout the year. The seasonal use of haulouts by sea lions and ultimately haulout-specific foraging patterns of Steller sea lions depend in part upon seasonally available prey species in each region."

3.1.7 Marine Habitat Use

Telemetry studies show that in winter adult females may travel far out to sea into water greater than 1,000 m deep (Merrick and Loughlin 1997), and juveniles less than 3 years of age travel nearly as far (Loughlin *et al*. 2003). The Platforms of Opportunity (POP) data base maintained by NMFS indicates that sea lions commonly occur near and beyond the 200 m depth contour (Kajimura and Loughlin 1988). Some individuals may enter rivers in pursuit of prey (Jameson and Kenyon 1977). In summer while on breeding rookeries, adult females attending pups tend to stay within 20 nm of the rookery (Calkins 1996, Merrick and Loughlin 1997).

Studies using satellite-linked telemetry have provided detailed information on movements of adult females and juveniles (Table 3.12). Merrick and Loughlin (1997) found that adult females tagged at rookeries in the central Gulf of Alaska and Aleutian Islands in summer made short trips to sea (mean distance 17 km, maximum 49 km) and generally stayed on the continental shelf. Adult females with satellite transmitters in the Kuril Islands in summer made short at-sea movements similar to those seen in Alaska (Loughlin *et al.* 1998). In contrast, during winter adult females ranged more widely (mean distance 133 km, maximum 543 km) with some moving to seamounts far offshore (Merrick and Loughlin 1997).

Behavioral observations indicate that lactating females spend more time at sea during winter than in the summer. Attendance cycles (consisting of one trip to sea and one visit on land) averaged about 3 days in winter and 2 days in summer (Trites and Porter 2002, Milette and Trites 2003, Trites *et al.* 2006b, Maniscalco *et al*. 2006). Time spent on shore between trips to sea averaged about 24 hours in both seasons. The winter attendance cycle of dependent pups and yearlings averaged just over 2 days, suggesting that sea lions do not accompany their mothers on foraging trips (Trites and Porter 2002, Trites *et al.* 2006b). Foraging trips by mothers of yearlings were longer on average than those by mothers of pups (Trites and Porter 2002).

Merrick and Loughlin (1997) found that most of the pups tracked during winter made relatively short trips to sea (mean distance 30 km), but one moved 320 km from the eastern Aleutians to the Pribilof Islands. Additional studies on immature Steller sea lions indicate three types of movements: long-range trips (greater than 15 km and greater than 20 h), short-range trips (less than 15 km and less than 20 h), and transits to other sites (Loughlin et al. 2003, Raum-Suryan et al. 2004). Long-range trips started around 9 months of age and likely occurred most frequently around the time of weaning while short-range trips happened almost daily (0.9 trips/day, n = 426 trips). Transits began as early as 2.5-3 months of age, occurred more often after 9 months of age, and ranged between 6.5 - 454 km (ADF&G unpublished data, Loughlin *et al.* 2003). Some of the transit and short-range trips occurred along shore, while long-range trips were often offshore, particularly as ontogenetic changes occurred.

Overall, the available data suggest two types of distribution at sea by Steller sea lions: 1) less than 20 km from rookeries and haulout sites for adult females with pups, pups, and juveniles, and 2) much larger areas (greater than 20 km) where these and other animals may range to find optimal foraging conditions once they are no longer tied to rookeries and haulout sites for nursing and reproduction. Loughlin (1993) observed large seasonal differences in foraging ranges that may have been associated with seasonal movements of prey, and Merrick (1995) concluded on the basis of available telemetry data that seasonal changes in home range were related to prey availability.

3.1.7.1 Foraging Behavior: Published Telemetry Studies

Adult foraging behavior

Limited data are available concerning the foraging behavior of adult Steller sea lions. Adult females alternate trips to sea to feed with periods on shore when they haul out to rest, care for pups, breed, and avoid marine predators. Conversely, territorial males may fast for extended periods during the breeding season when they mostly remain on land (Spalding 1964, Gentry 1970, Withrow 1982, Gisiner 1985). Females with dependent young are constrained to feeding relatively close to rookeries and haulouts because they must return at regular intervals to feed their offspring.

Merrick *et al.* (1994) and Merrick and Loughlin (1997) present information on the dive characteristics and foraging behavior of a small sample of adult Steller sea lions in Alaska; Loughlin *et al.* (1998) provided similar information for the Kuril Islands, Russia. Merrick *et al.* (1990) and Brandon (2000) presented information on attendance behavior of adult females with VHF radio-transmitters in the Kuril Islands and Alaska, respectively. Trites and Porter (2002) and Milette and Trites (2003) documented attendance patterns from behavioral observations. These studies showed that during the breeding season, adult female Steller sea lions generally spent about half their time at sea on relatively brief (about 0.8 days) foraging trips. Dives tended to be shallow (mean = 21 m), brief (mean = 1.4 min), and frequent (about 13 per hour) (Table 3.13). Observations during winter showed that females with suckling yearlings (19-21 months of age) had feeding trips of about 2.5 d while those with young-of-the-years (7-9 months of age) had trips lasting 2.0 d; time on shore for lactating females averaged 15.4 h (Trites and Porter 2002). Merrick and Loughlin (1997) found that during summer adult females made trips to sea that averaged 17 km from the rookery (range 3-49 km; SE = 4.6; Table 3.12). Outside of the breeding and pupping season, movements may be less constrained although animals still return to coastal haulouts to rest. For adult females tracked during winter by Merrick and Loughlin (1997), the mean trip duration was 204 hours and average distance moved offshore was 133 km (range 5-543 km; SE = 59.9).

In Southeast Alaska, adult females with pups made relatively brief foraging trips (mean 19.1 hr) while those with yearlings or without pups were much longer in duration; during winter female trips to sea had a mean of 56.1 hr with a maximum of 169 hr (Swain 1996). Those females with pups remained within 20 nm of the rookery and mean foraging distance from the Hazy Island and Forrester Island rookery complex was 14.5 km offshore (Calkins 1996).

Additional research integrating three separate electronic devices has provided some fine-scale information on Steller sea lion foraging. The combined data (collected from a stomach temperature transmitter that indicates when Steller sea lions ingest prey, a data logger that records depth and velocity, and an SDR to determine locations) provide insights to when and where Steller sea lions may be foraging. Andrews *et al.* (2002) used this approach on adult females in summer at Forrester Island (SE) and Seguam Island (BSAI) in 1994 and 1997; the data indicated nearly all prey ingestion occurred when animals repeatedly exhibited deep dives (greater than 10m), and that prey was ingested during all at-sea trips that included such foraging dives. However, long periods of time often elapsed and large distances were covered between successful foraging events. Adult females began foraging dives greater than 10 m within 8-26 minutes after departing a rookery, yet the first prey was not ingested until 0.9 to 5.1 hours after departure.

Frid et al. (2008) compared predictions from a dynamic state variable model with data from March 2004 on the behavior of seven juvenile Steller sea lions from PWS instrumented with satellite-linked time-at-depth recorders. Based on these admittedly limited data, the authors concluded they found "…preliminary support for the hypothesis that, during winter in Prince William Sound, juvenile SSLs (a) underutilise walleye pollock, a predictable resource in deep strata, due to predation risk from Pacific sleeper sharks, and (b) underutilise the potential energy bonanza of inshore aggregations of Pacific herring due to risk from either killer whales, larger conspecifics, or both. Further, under conditions of resource scarcity—induced by overfishing, long-term oceanographic cycles, or their combination—trade-offs between mortality risk and energy gain may influence demographic parameters."

Juvenile Foraging Behavior

The need to understand the behavior of juvenile Steller sea lions has focused research effort in recent years and resulted in a relatively large sample data set for animals less than 3 years of age (Loughlin *et al.* 2003, Raum-Suryan *et al.* 2004, Rehberg 2005, Pitcher *et al.* 2005, Fadely *et al.* 2005, Briggs *et al.* 2005, Call et al. 2007). In general, juveniles in their second year are capable of diving to adult depths but tend not to as often as older animals (Loughlin *et al.* 2003, Rehberg 2005). Rehberg (2005) found that young-of-year sea lions also tend to increase the greater relative proportion of their swimming and diving behavior from diurnal to nocturnal periods. Mean dive depth and duration increases with age (Pitcher et al. 2005, Fadely et al. 2005, Briggs *et al.* 2005) and is predicted to increase in a positive relationship with body mass up to about 10 years of age (Pitcher *et al.* 2005). Departure times from haulouts of juvenile sea lions in the eastern and central Aleutian Islands and the central Gulf of Alaska coincided with dusk, but departures occurred throughout the day in Prince William Sound and Southeast Alaska (Call et al. 2007). Briggs *et al.* (2005) found that eastern Gulf of Alaska and Prince William Sound juveniles in the winter made a majority of their dives during the day and switched to night time feeding during the summer. Tagged young-of-the-year animals during winter made trips offshore and along shore that averaged 15 hours long and extended to an average of 30 km (range 1-320 km; SE = 14.5). Loughlin *et al.* (2003) defined three types of movements that vary with age and body mass for juvenile Steller sea lions at sea: 1) transits between land sites with a mean distance of 66.6 km; 2), long-range trips (less than 15 km and greater than 20 hours); and 3) short-range trips (less than 15 km and less than 20 hours). Likewise, Raum-Suryan *et al.* (2004) reported that greater than 90% of round trips were less than 15 km from haul-outs and 84% were less than 20 hours in duration.

3.1.7.2 Foraging Behavior: Unpublished Dive-Filtered Telemetry Data

To investigate foraging behavior, an analysis of juvenile Steller sea lion dive locations was completed using satellite telemetry data obtained from 2000 to 2005 following the same methods used and presented by NMFS (2003) (NMFS 2006b). The previous analysis was based on summarized telemetry data collected from 63 sea lions by the National Marine Mammal Laboratory (NMML) during 2000 to 2003. The current analysis was updated with data from satellite tag deployments performed by the Alaska Department of Fish and Game (ADFG) and NMML deployments since the time of the previous analysis, and updates text, tables, and graphic representations (NMFS 2006b). Results from the current analysis were used to update tables II-6 (Table 3.14), II-7 (Table 3.15), II-9 (Table 3.16) of NMFS (2003), and added Table 3.17.

NMML captured and equipped an additional 23 juvenile Steller sea lions with satellite linked time depth recorders (SDRs) between 2003 and 2006. No additional sea lions have been captured and monitored using satellite telemetry by NMML since that time due to permitting and logistical constraints. Additionally, ADFG and NMML collaborated to combine their respective Steller sea lion satellite tagging databases (Call et al. 2007). As a result of this effort 32 Steller sea lions captured by ADFG from 2000-2002 were also included. A total of 116 animals (63 previous, 53 new) ranging in age from 3-26 months old at time of capture were used in this updated analysis (Table 3.18). The Alaska Department of Fish & Game has captured and recaptured the same instrumented juvenile sea lions in Prince William Sound in 2006-7 and again in 2007-8 as part of a longitudinal study of animal condition. However the results of this work were not available at the time of this writing.

The previous analysis in NMFS (2003) used 10,006 dive associated locations from the 63 animals. In this updated analysis all locations that were transmitted from land (based on the "akland polygon" GIS cover) were removed (NMFS 2006b). This reduced the 10,006 locations from the previous NMFS (2003) dataset to 8,141 at-sea locations. Also, the previous analysis used locations that had an Argos Location Class (LC) of 3, 2, 1, 0, or A, were associated with diving to >4 m, and were wet at the time of transmission. Determination of wet or dry status at the time of transmission can be derived from two data sources: 1) land/sea status message, and 2) timeline data. The previous analysis determined whether the satellite tag was wet or dry from the land/sea data message only. However, including timeline data that indicated wet or dry status when the land/sea data did not added 172 correctly classified locations. This analysis uses both land/sea and timeline data to determine if a location was wet or dry at the time of transmission.

A total of 65,150 locations from all 116 animals were extracted from the database for processing and 14,441 (22.17%) were used in the new analysis. The remaining 50,709 locations were removed because they were LC B (14,587 or 22.39%), did not fit the dive >4 m criteria (12,335 or 18.39%), were on land locations (9,281 or 14.25%), were determined invalid due to duplicity, time of transmission, poor quality (LC Z) or were calculated prior to deployment (6,703 or 10.29%), were determined to be dry at the time of transmission (5,307 or 8.15%), or due to other error-checking (2,496 or 3.83%).

Compared to the data available for NMFS (2003), sample sizes for winter locations are doubled, Prince William Sound was added as a new area, and 17 new deployments were made in the Central Aleutian Islands. In general results suggest a slightly decreased proportion of dive-associated locations within the 0-10 nm zone, and increased use of habitats >20 nm from shore or nearest listed haulouts or rookeries compared to the NMFS (2003) analysis. Distributions of proportions of dive-associated locations were similar whether based on distance from shore or distance from the nearest listed haulout or rookery, but it is important to note that these distance measures are not directly comparable. That is, though a location may have been >20 nm from a nearest listed haulout or rookery, that location could have been anywhere between adjacent to shore to >20 nm from the nearest point of land. Most locations >20 nm from a listed haulout or rookery fell outside critical habitat.

Juvenile sea lions >10 months old had a greater proportion of dive-associated locations in zones >10 nm than did 3-10 month olds in both summer and winter. Juveniles >10 months old also showed nearly equal use of the 10-20 nm zone during summer and winter, but a much greater use of habitats >20 nm in summer compared to winter periods.

Regional differences in habitat use were evident. In particular, dive-associated locations in the Central-Western Aleutian Islands area showed a much greater use of habitats >20 nm from the nearest listed haulout or rookery than in other areas, and 22% of the >20 nm zone locations in summer were outside of critical habitat. Most of these locations were in the Bering Sea.

A recent paper by scientists from NMFS and ADF&G (Call et al. 2007) compared at sea and on shore activity behavior between juvenile Steller sea lions in the Western and Eastern stocks. This analysis used the same data presented previously but with a slightly different objective. In general this work found no difference in the period of time spent on shore between sex, region, year or age but did find that sea lions in the eastern and central Aleutian Islands and central GOA tended to go to sea at night and return just after sunrise. In contrast the sea lions from Prince William Sound and Southeast Alaska the arrivals and departures occurred throughout the day. Time at-sea increased with age, but sea lions from the central and eastern Aleutian Islands and central Gulf of Alaska spent more time at-sea at earlier ages than did sea lions tracked in Prince William Sound and Southeast Alaska.

3.1.8 Prey

Steller sea lions are generalist predators that eat a variety of fishes and cephalopods distributed from nearshore demersal to epi-pelagic habitats (Pitcher 1981, Calkins and Goodwin 1988, NMFS 2000, Sinclair and Zeppelin 2002, Womble and Sigler 2006, Gende and Sigler 2006, Waite and Burkanov 2006), Other marine mammals and birds are consumed upon occasion (Gentry and Johnson 1981, Pitcher and Fay 1982, Daniel and Schneeweis 1992, Calkins 1988), however fishes and cephalopods form the mainstay of Steller sea lion diet. Diet studies are central to understanding all other aspects of Steller sea lion life history. Diet differentiation at regional and local scales across the range of the western DPS served as the earliest indicator of habitat requirements and metapopulation structure since confirmed by genetic analysis (O'Corry-Crowe et al. 2006; Sinclair and Zeppelin 2006, Sinclair et al. 2005). The feeding ecology of Steller sea lions has been described in detail in various NMFS documents including the initial Steller Sea Lion Recovery Plan (NMFS 1992), revised draft Steller Sea Lion Recovery Plan (NMFS 2006), and in previous Section 7 consultations under the ESA (NMFS 1998, 2000, 2001, and 2003). Readers are referred to those documents for additional information.

3.1.8.1 Prey Consumption

Overall, the diet of Steller sea lions across their range was not consistently studied prior to the early 1990s. Sampling techniques used to evaluate diet have expanded over the years from the identification of prey remains in stomachs and scats, to the decoding of prey signatures in fatty acid and stable isotope profiles in tissue. Each technique provides a valid perspective of sea lion diet, but each also has unique biases regarding unequal representation of specific prey by species or size. Scat data, like stomach contents, may be biased (e.g., prey species may have hard parts that are more or less likely to make it though the digestive tract; see Cottrell and Trites 2002, Tollit *et al.* 2003, 2004a; Gudmundson et al. 2006). For example, hard parts from very large prey (giant octopus) may be regurgitated or retained in the stomach never passing through to the scat (Sinclair and Zeppelin 2002). Likewise, small otoliths (smelts, juvenile fishes) tend to flush through the digestive system more quickly than larger ones, remaining intact and more abundant in scats than in stomachs (Sinclair et al. 2000). Fatty acid and stable isotope analyses provide a historical record of primary prey consumed but, under value the importance of occasional or seasonal prey targeted during critical periods or different life stages. When considered together, each technique provides a full view of Steller sea lion diet, and our growing understanding of the limitations of each allows us to differentiate between apparent and real changes in diet over time.

<u>Stomach Analyses</u> - In California and Oregon Steller sea lions are known to have eaten rockfish, hake, flatfish, salmon, herring, skates, cusk eel, lamprey, squid, and octopus (Fiscus and Baines 1966, Jameson and Kenyon 1977, Jones 1981, Treacy 1985, Brown *et al.* 2002). Principal prey in British Columbia has included hake, herring, octopus, Pacific cod, rockfish, and salmon (Spalding 1964, Olesiuk *et al.* 1990). The most commonly identified prey items in Southeast Alaska were walleye pollock, Pacific cod, flatfishes, rockfishes, herring, salmon, sand lance, skates, squid, and octopus (Calkins and Goodwin 1988, Trites *et al.* 2006d).

Considerable effort has been devoted to describing the diet of Steller sea lions in the Gulf of Alaska, Aleutian Islands, and Bering Sea (Table 3.20; NMFS 2000). In the mid 1970s and mid 1980s, Pitcher (1981; n = 250) and Calkins and Goodwin (1988; n = 178) described Steller sea lion diet in the Gulf of Alaska by examining stomach contents of animals collected for scientific studies. Walleye pollock was the principal prey in both studies; octopus, squid, herring, Pacific cod, flatfishes, capelin, and sand lance were also consumed frequently. Stomachs of Steller sea lions collected in the central and western Bering Sea in March-April 1981 contained mostly pollock and also Pacific cod, herring, sculpins, octopus, and squid (Calkins 1998).

Merrick and Calkins (1996) analyzed Kodiak Island region sea lion stomach contents (n = 263) data from the 1970s and 1980s for seasonal patterns of prey use (see NMFS 2000 their Table 5.2). They found a significant seasonal difference in diet for the 1970s. Walleye pollock was the most important prey in all seasons except summer in the 1970s, when the most frequently eaten prey type was small forage fishes (capelin, herring, and sand lance). No significant seasonal differences were found in the 1980s. Researchers noted that, overall, small forage fishes and salmon were eaten almost exclusively during summer, while other fishes and cephalopods were eaten more frequently in spring and fall.

NMFS (2000; their Table 4.4 and Figure 4.5) compiled all the available data on prey occurrence in stomach contents samples for the eastern and western Steller sea lion populations for the 1950s - 1970s and the 1980s. For both populations the occurrences of pollock, Pacific cod, and herring were higher in the 1980s than in the 1950s -1970s. These results suggest that the dominance of pollock in the Steller sea lion diet over much of its range may have changed over time. However, studies completed prior to the mid-1970s had small sample sizes and more limited geographic scope. As such, caution should be exercised when extrapolating from these limited samples to a description of the diet composition of Steller sea lions in the 1950s - 1970s.

At the far western end of the Steller sea lion range, Atka mackerel, sand lance, rockfish, and octopus were identified as important foods at the Kuril Islands in collections made in 1962 (Panina 1966), and pollock, Pacific cod, saffron cod, cephalopods, and flatfish were the main prey of 62 animals collected near Hokkaido, Japan from 1994 to 1996 (Goto and Shimazaki 1998). Waite and Burkanov (2006) found that the diet of sea lions in the Russian Far-East is similar to that reported in scats collected in the central and western Aleutian Islands by Sinclair and Zeppelin (2002); Atka mackerel, pollock, and salmon were the most commonly reported prey items. The most notable difference was the abundance of sculpins consumed by sea lions in Russia (Waite and Burkanov 2006).

Stomach contents analysis indicates that Steller sea lions have a mixed diet. Although it is not uncommon to find stomachs that contain only one prey species, most collected stomachs contained more than one type of prey (Merrick and Calkins 1996, Calkins 1998). Merrick and Calkins (1996) found that the probability of stomachs containing only pollock was higher for juveniles than for adults, and small forage fish were eaten more frequently by juveniles while flatfish and cephalopods were eaten by adults more frequently.

<u>Scat Analyses</u> - Since 1990, additional information on Steller sea lion diet in Alaska has been obtained by analyzing scats collected on rookeries and haulouts (Merrick *et al.* 1997, NMFS 2000, Sinclair and Zeppelin 2002, NMFS 2006b, Womble and Sigler 2006). As noted previously, scat data, like stomach contents, may be biased (e.g., prey species may have hard parts that are more or less likely to make it though the digestive tract; see Cottrell and Trites 2002, Tollit *et al.* 2003, 2004a), but their accessibility in large numbers allow a description of prey used over a wide geographic range from Kodiak Island through the western Aleutian Islands and for both summer and winter. Analysis of scats collected in the 1990s (Sinclair and Zeppelin 2002), from 1999-2001 (Sinclair et al. 2005) and from 1999-2005 (Table 3.21 and Figure 3.20) show that pollock continue to be a dominant prey in the Gulf of Alaska, eastern and central Aleutians and that Atka mackerel was the most frequently occurring prey in the western Aleutian Islands scats. Pacific cod is also an important prey in winter, especially in the Gulf of Alaska and eastern Aleutian islands. Salmon was eaten most frequently during the summer months in the Gulf of Alaska, and eastern and central Aleutians, but in the western Aleutians salmon was most frequently eaten in winter. Cephalopods continue to rank as important prey in the summer in the western Aleutian Islands, however the giant octopus (*Octopus dofleini*), so highly represented in stomach contents from this area into the 1980s, is not recorded in recent studies based on scats. Results based on scats also indicated a wide variation in prey; certain species that appear to be minor dietary items when data are tabulated for large regions may actually be highly ranked prey for specific rookeries and seasons (Sinclair and Zeppelin 2002, Womble and Sigler 2006).

Trites and Calkins (2008) examined scat collected from a rookery and adjoining bachelor male site in Southeast Alaska to determine if the diet was similar. They found that salmon and herring dominated the summer scats of lactating females, while pollock and rockfish dominated the scat of breeding-age males and as such, scat collected at male haulouts could not be used as a proxy for female diet.

Stable isotope analaysis - The diet of Steller sea lions based on scats mirrors findings based on stable isotope analyses of blood including east to west regional differences in foraging (Kurle and Sinclair 2003, Kurle and Gudmundson 2007). The general pattern of increasing nitrogen isotope values among adult female Steller sea lions since the 1960s supports conclusions based on stomach and scat analysis and fisheries surveys that a reduction in forage fishes and increase in demersal and semi-demersal groundfish has occurred in the North Pacific ecosystem (Conners et al. 2002, Hobson et al. 2004, York et al. 2008).

3.1.8.2 Prey Characteristics

The primary prey of Steller sea lions are fish and cephalopods, which tend to have a broad, but predictable range in temporal, spatial, and seasonal nearshore availability. Typically, many prey species make predictable seasonal migrations from pelagic to nearshore waters where they form large spawning concentrations. Prey is then further concentrated by local transition boundaries such as frontal zones and bathymetric features such as submarine channels (Sinclair *et al.* 1994). Steller sea lions appear to have the foraging flexibility to take advantage of both the predictable behavioral traits of these prey species (Sigler *et al.* 2004), as well as the localized oceanographic conditions that enhance prey concentrations (Sinclair and Zeppelin 2002, Trites *et al.* 2006a). Steller sea lions are able to respond to changes in prey abundance. An example is the increase in consumption of arrowtooth flounder in the Gulf of Alaska between the 1970s (Pitcher 1981) and the 1990s (Sinclair and Zeppelin 2002). Another example is the geographic variation in diet observed during the 1980s and 1990s; east to west the primary prey varies from Pacific hake (Brown *et al.* 2002) to walleye pollock and then to Atka mackerel (Sinclair and Zeppelin 2002).

Prey species can be grouped into those that tend to be consumed seasonally, when they become locally abundant or aggregated when spawning (e.g., herring, Pacific cod, eulachon, capelin, salmon and Irish lords), and those that are consumed and available to sea lions more or less year-round (e.g., pollock, cephalopods, Atka mackerel, arrowtooth flounder, rock sole and sand lance; based on Pitcher 1981, Calkins and Goodwin 1988, Sinclair and Zeppelin 2002, Trites *et al.* 2006d, Womble and Sigler 2006). Some of the seasonal prey species occur most frequently in summer and fall (e.g., salmon and Irish lords) or winter and spring (e.g., herring, Pacific cod, eulachon, and capelin). There are also significant regional differences in the occurrences of some species (e.g., Atka mackerel are only in the Aleutian Islands, and arrowtooth flounder occur in the Gulf of Alaska).

Prey size varies greatly ranging from several centimeters in length for species such as sandlance and capelin to over 60 cm in length such as salmon, skates, Pollock and cod. Remains of pollock exceeding 70 cm in length have been recovered in Steller sea lion scats (Tollit *et al.* 2004b, Zeppelin *et al.* 2004). Walleye pollock otoliths recovered from stomachs collected in the Bering Sea and Gulf of Alaska have shown that all age classes of sea lions eat a wide range of sizes (Calkins and Goodwin 1988, Frost and Lowry 1986, Lowry *et al.* 1989, Merrick and Calkins 1996, Calkins 1998). The overlap in the size distribution of pollock and Atka mackerel taken by Steller sea lions and commercial fisheries was revisited by Tollit *et al.* (2004b) and Zeppelin *et al.* (2004). Their results indicate that sea lions consume larger fish than previously estimated and that the overlap in size was 68% for pollock and 53% for Atka mackerel (Zeppelin *et al.* 2004; samples from the winter of 1998 to the summer of 2000). Analysis of scats containing Pacific cod (Table 3.22) indicates that in the summer 75% of the Pacific cod eaten are very large (35-60 cm) and in the winter 60% are very large (NMFS 2006b).

Prey quality is also an important factor which may change both seasonally and geographically and vary in relevance with the sex and life stage of the predator. For instance, while pollock is a staple for both sexes of juvenile and adult Steller sea lions, it may be particularly important to growing juveniles that require a high protein diet (see: Fritz and Hinckley 2005). In contrast, adult females may emphasize high fat foods during periods of lactation in order to maintain both adequate milk supply and body condition. Schaufler *et al.* (2006) examined geographical variation in Steller sea lion prey quality between the western and eastern DPSs. They collected and analyzed over 1,200 whole fish representing sea lion prey species from the Aleutian Islands and southeastern Alaska. Overall, the mean energy density for 22 forage species from southeastern Alaska (1.62 ± 0.02 kcal per g on a wet weight basis) was greater than that of 15 species from the Aleutians (1.44 ± 0.03 kcal per g). Arrowtooth flounder, sandfish and squid had significantly higher energy density in southeastern Alaska than the Aleutians. Pacific cod, on the other hand, had a significantly higher energy density in the Aleutians, as did rockfish. Overall, this study suggests that sea lions encounter (on average) a prey field in the Aleutian Islands with lower energy density than in Southeast Alaska. Pollock from both regions had similar estimated energy densities, which is of particular interest because some of the sharpest declines in sea lion populations have occurred in areas where pollock dominates the diet and pollock is a major component of the diet of both stocks. In other words, the results suggest that the quality of pollock in both regions is similar and is not likely to be an energetic factor in the decline of Steller sea lions. Comparisons of average energy densities for other species collected from both regions revealed differences that could be attributed to factors other than geographical location. For instance, Aleutian Pacific cod were larger than those from Southeast Alaska. The size-related increases in energy density may be related to changes in energy allocation with age.

Kitts *et al.* (2004) examined the seasonal changes in proximate nutrients of pollock collected in the Bering Sea. Mean energy density (dry mass) of pollock peaked in October then declined and remained low throughout winter. Energy recovery occurred in the summer months (post-spawning) with strong recovery observed in female fish caught in July. Contrary to whole fish carcass energy contents, both total protein and moisture contents were at their highest levels in winter (January) when total crude lipid content was at its lowest ($p < 0.05$). This trend gradually declined to its lowest levels in the fall when lipid content was high. The decline in total lipids during winter seasons appeared to parallel gonad development during the pre-spawning period. The authors concluded that the nutrient content of walleye pollock may have some impact on the Steller sea lions that feed on them, particularly the energetic value that appears to be relatively low during important feeding periods.

Logerwell and Schaufler (2005) presented proximate composition data for several species believed to be significant Steller sea lion prey items from the Gulf of Alaska, Bering Sea, and Aleutian Islands. Laboratory analyses of lipid, protein, moisture, and ash compositions were presented for pollock, Pacific herring, Atka mackerel, sandlance, and Pacific cod, as well as salmonids and various species of rockfish, squids, and skates. Pacific Herring, sandlance, and rockfish were found to have high average energy densities (>6 kJ/g wet weight), while Atka mackerel, capelin, salmon, sandfish, pollock, Pacific cod, squid, skates, and rock sole had intermediate average energy densities (3-6 kJ/g wet weight). Smooth lumpsuckers and snailfish were found to have low energy densities (<3 kJ/g wet weight). Although forage fish are generally considered to have higher lipid contents and energy densities than groundfish, not all groundfish species examined had energy densities lower than forage fish. For instance, the rockfish examined had high energy densities similar to that of Pacific herring. Furthermore, some forage fish such as capelin had intermediate energy densities, similar to those of pollock or Pacific cod. Multiple ages and spawn states were analyzed for pollock, as were different geographical regions. Pre-spawn pollock (collected between November and March) had greater energy densities ($p<0.01$) than did post-spawn pollock (collected between May and August), similar to previously described results in Smith *et al*. (1988), where pollock were found to lose 46% of their energy content from spawning. Pacific cod have similarly been shown to expend ~30% of their energy content immediately prior to spawning, as described in Smith *et al.* (1990). Comparing data in Logerwell and Schaufler (2005) with previously published results shows that the energy densities of northern rockfish and Pacific salmon were greater during the summer months. Some species indicated other significant differences, such as Atka mackerel who had a gender-related variation in average energy density during the summer spawning season, with males having energy densities higher than females ($p<0.05$). Finally, geographic comparisons indicated that pollock collected from the eastern Bering Sea (non-spawning season) had higher energy densities than those in the Aleutian Island region, which were in turn higher than those from the Gulf of Alaska. However, an additional study that included samples from Southeast Alaska found that there was no difference in energy density between the Aleutian Pollock and those in Southeast Alaska (Schaufler et al. 2006). In contrast, Pacific cod during the spawning season showed no geographical variation in energy density. In summary, estimation of the energetic value of prey species in the North Pacific is complicated by seasonal and spawn-state variations, as well as some species-dependent differences such as gender and geographical region.

3.1.9 Nutritional Requirements

The amount of food required to provide for energetic needs can vary greatly depending on the energy content of the food and physiological status of the animal (Innes *et al.* 1987). Steller sea lion pups grow rapidly during their first weeks of life and require a substantial intake of energy that is supplied by the mother. Nursing Steller sea lion pups at Año Nuevo Island consumed 1.5 to 2.4 liters of milk per day with a fat content of 23 to 25% (Higgins *et al.* 1988).

Nutritional requirements for free-ranging Steller sea lions have not been measured. Kastelein *et al.* (1990) provided data on food consumption of 10 animals kept in captivity and fed a diet that included several fish species and squid. Average daily consumption increased from 4 to 6 kg per day for 1 year olds to 10-13 kg per day at age 5, with males generally eating more than females. An adult male ate 18kg per day on average, and females increased their daily requirement by approximately 30% when they became sexually mature and produced pups.

Keyes (1968) concluded that adult, non-pregnant, non-lactating pinnipeds would require 6 to 10% of their body weight in food per day. Similarly, captive feeding experiments with 1 to 2 year olds indicate that the daily maximum digestive limit of Steller sea lions (in terms of weight of prey consumed) is equivalent to about 14 to 16% of their body weight (Rosen and Trites 2004).

Kastelein *et al.* (1990) estimated that the amount of food found in Steller sea lion stomachs has usually been on the order of one-fourth of their average daily requirements but did not account for digestion suggesting that meal sizes may at times be much larger. The stomach of a 311 kg sea lion collected in the Bering Sea contained 24 kg of partially digested pollock, which amounted to 7.7% of the animal's body weight (L. Lowry unpublished data). Kastelein *et al.* (1990) also reported that after a day of fasting, captive Steller sea lions ate meals that were about 25% larger than their daily average leading the authors to surmise that large sea lions have a relatively large stomach capacity, which is probably an adaptation that allows them to feed at infrequent intervals.

Winship *et al.* (2002) used bioenergetic modeling to estimate the food requirements of free-ranging Steller sea lions. The model incorporated information on age- and sex-specific bioenergetics of individual animals, population size and composition, and the composition and energy content of the diet. Their model predicted that juvenile animals have higher mass-specific food requirements than adults (greater than 10% versus 5 to 6% of body mass per day) and that a lactating female needs to consume about 70% more food on average if her pup is entirely dependent on her for energy during its first year of life. The mean predicted food requirement of an average Steller sea lion consuming an average Alaskan diet was 17 kg per day.

When assessing the suitability of prey for Steller sea lions in the wild, the important issue is the net amount of nutrition that can be gained from time spent feeding. Nutrition to be gained must take into account energy value of the prey as well as protein, vitamins, minerals, and micronutrients. Quantifying the biological value of prey species and the physiological consequences of inadequate prey is an area where laboratory studies can provide important data. For example, the energetic differences between prey species cannot be solely calculated from measures of gross energy content. The differences in energy due to lipid and protein composition are exaggerated by even higher losses from the heat increment of feeding and digestive efficiency of pollock (Rosen and Trites 1997, 2000b).

Steller sea lions, at least adult females and juveniles, are unlike most marine mammals that store large amounts of fat to allow periods of fasting. Sea lions need more or less continuous access to food resources throughout the year (Williams 2006a) a schematic of the sea lion life cycle with an emphasis on reproduction. The sensitivity of sea lions to competition from fisheries may be higher during certain times of the year. Reproduction likely places a considerable physiological or metabolic burden on adult females throughout their annual cycle. Following birth of a pup, the female must acquire sufficient nutrients and energy to support both herself and her pup. The added demand may persist until the next reproductive season, or longer, and is exaggerated by the rigors and requirements of winter conditions. The metabolic requirements of a female that has given birth and then become pregnant again are increased further to the extent that lactation and pregnancy overlap and the female must support her young-of-the-year, the developing fetus, and herself (Williams 2006b). And again, she must do so through the winter season when metabolic requirements are likely to be increased by harsh environmental conditions.

There are few data available to determine the global prey requirements for Steller sea lions within critical habitat. The best information available is the analysis that was presented in the 2001 Biological Opinion (NMFS 2001) in Section 5.3.3. In that analysis, NMFS investigated the amount of biomass available by area in the EBS, AI, and GOA and the amount of prey the local populations of Steller sea lions may consume. A number of assumptions were made in the analysis and the reader should review Section 5.3.3. of NMFS (2001) for details of that exercise.

The forage ratios in 2000 for the Eastern Bering Sea, Aleutian Islands, and Gulf of Alaska are provided in Table 3.23. The forage ratio for sea lions in the Eastern Bering Sea is 446, much higher than the ratio of 46 for a “healthy” stock of Steller sea lions foraging on a theoretical, unfished groundfish population. Such a high ratio indicates that forage may be plentiful in the Eastern Bering Sea at least at the gross annual assessment. The forage ratio for the GOA was 17 and AI was only 11, substantially lower than the EBS and also well below the theoretical "healthy" range. This represents 37% of the biomass in the GOA and 24% in the AI. Interpretation of these ratios is difficult without further information on the seasonal availability, distribution and patchiness, and the fishery removals. However, this does indicate that fishery removals are more likely to be adverse in the AI and GOA where prey biomass may already be below that necessary to support a recovered sea lion population. Recent oceanographic information on these areas generally agree with forage ratio results that these areas may be less productive and more sensitive to fishery removals, especially in the Aleutian Islands (Ladd *et al.* 2005, Hunt and Stabeno 2005, Stabeno *et al.* 2005).

3.1.10 Ontogeny of Steller Sea Lions - Physiology

Fundamental to an evaluation of the effects of commercial fisheries on Steller sea lions is an understanding of the physiological adaptations that underlie the sea lion’s role in the Bering Sea and Gulf of Alaska ecosystems. Steller sea lions spend time on land at rookeries and haulout sites for reproduction, lactation, molting and resting, and undertake foraging trips to sea. The relative time spent at sea depends upon age and size, season, reproductive status, and the availability of forage (Boyd 1995 and 1996). Trips to sea may be made for a variety of reasons, for foraging but also for seasonal or age-specific movements along the coast. While foraging, swimming and diving behaviour are controlled by a compromise between the necessity to breathe at the surface and to submerge to seek and consume prey. In addition to the abundance and distribution of prey, the time a sea lion spends submerged will depend upon physiological adaptations for maximizing time underwater. This will be a result of the how fast oxygen stores are utilized (i.e., metabolic rate), and how much oxygen is stored in the body, and the conflicting demands of diving and exercise (Castellini 1991, Boyd 1997). Pinnipeds exhibit many physiological strategies to increase dive duration (Boyd and Croxall 1996, Boyd 1997). A description of the physiological development of foraging is described below.

3.1.10.1 Physiology at Birth

The breeding season extends from May to early August and peak pupping occurs during late June (Merrick *et al.* 1995, Pitcher *et al.* 2001). Adult females spend 2 to 3 days on the rookery prior to parturition (Higgins *et al.* 1988) before giving birth to a single pup. Pups nurse within 2 hours of birth and durations of suckling bouts are similar for males and females, increasing from an average of 11 minutes during the first week of life to approximately 21 minutes by 5 weeks of age (Higgins *et al.* 1988). Overall, female pups ($\bar{x}$ = 26.2 kg, SE = 0.2) ranging in ages up to one month old are significantly lighter than male pups ($\bar{x}$ = 30.5 kg, SE = 0.3; Merrick *et al.* 1995). These results are similar to Brandon *et al.* (2005) who found that female neonates (1 to 5 days old) weighed an average of 19.6 kg (1.80 SD) at birth, which was 15 % less than that of males ($\bar{x}$ = 22.6 kg, SD = 2.21). Additionally, Brandon *et al.* (2005) found that standard length and auxiliary girth of female neonates were significantly less than corresponding data for male neonates. Both male and female pups gain 1.0 to 2.3% of their birth weight per day during the first six weeks, which is greater than growth rates reported for most species of otariids (Brandon *et al.* 2005). Because neonatal mass differed between males and females, but growth rates were similar, Brandon *et al.* (2005) suggested maternal investment was greater in male pups during gestation, but not during early lactation.

At birth, blood chemistry and hematology values are similar between males and females and neonates have greater levels of hematocrit (Hct), hemoglobin (Hb), and mean corpuscular hemoglobin concentration (MCHC) than older pups (Rea *et al.* 1998, Richmond *et al.* 2005). Richmond *et al.* (2005) examined the development of diving physiology for juvenile Steller sea lions (1-29 months old) and found that hematology values decreased after birth, reached a minimum in animals of approximately 3 months of age, and then increased until 9 months of age when values were similar to those of older age classes of Steller sea lions. Although it is difficult to determine whether differences in hematological values are a result of nutritional status or age, this trend is typical for other mammalian neonates (Rea *et al.* 1998). Plasma water content also increases with age as fat concentration in the milk decreases over the course of lactation (Rea *et al.* 1998).

After birth, mothers nurse their pups for 3-12 days before starting a series of trips to sea, which range in duration from 7-62 hours depending on geographic location (Higgins *et al.* 1988, Hood and Ono 1997, Brandon 2000). Pup gender does not appear to influence maternal attendance patterns (the cycle of time at sea and time on shore), but mothers increase their time at sea as pups get older (Higgins *et al.* 1988). Pups remain on the rookery for the first few weeks of life while females forage at sea (Gentry 1970, Higgins *et al.* 1988, Hood and Ono 1997, Trites and Porter 2002) and enter the water 2 to 4 weeks after birth to play in shallow water around the periphery of the rookery (Sandegren 1970). During this time there is a significant increase in time spent swimming as pups age (Hood and Ono 1997). Eventually, pups start accompanying their mother to sea on short trips when they reach approximately 1 month of age (Sandegren 1970).

3.1.10.2 Dispersal from Rookeries and Foraging

Steller sea lion pups presumably disperse from the rookery with their mother 2 to 3 months after birth (Calkins and Pitcher 1982, Merrick *et al.* 1988, Raum-Suryan *et al.* 2004). Female Steller sea lions and their pups adopt a strategy of central place and multiple central place foraging to deal with the temporal and spatial distribution of prey resources (Raum-Suryan *et al.* 2004). As pups get older, it is believed they make independent trips away from haulout sites while their mothers are at sea (Trites and Porter 2002). During winter, trips by females with pups and older juveniles average 2.0 and 2.5 days, respectively (Trites and Porter 2002). Timing of weaning is not well understood, but occurs as early as 4 months to as late as 3 years of age (Pitcher and Calkins 1981, Porter 1997, Loughlin 1998, Trites and Porter 2002, Trites et al. 2006). Studies based on physiological development (Richmond *et al.* 2005, 2006), changes in fatty acid profiles of pup blubber (Beck *et al.* 2007), and changes in movements and dive characteristics (Loughlin *et al.* 2003, Fadely *et al.* 2005, Rehberg 2005) suggest that weaning occurs after 9 to 12 months of age. Raum-Suryan *et al.* (2004) found that changes in round trip distance and duration occurred from April to June for YOYs and older individuals, possibly indicating that annual timing of weaning may be less variable than age of weaning.

Studying the ontogeny of foraging behavior is crucial for understanding life histories (Horning and Trillmich 1999). Additionally, the development of movement patterns with age is important for understanding individual foraging patterns and how those patterns may be influenced by the availability of prey resources (Raum-Suryan *et al.* 2004). Telemetry has been an important tool for investigating the movements, foraging behavior, habitat selection, and ontogeny of juvenile Steller sea lions. Telemetry studies have indicated that trip duration and distance vary seasonally, but rarely exceed 20 h and 20 km, respectively (Merrick and Loughlin 1997, Loughlin *et al.* 2003, Raum-Suryan *et al.* 2004, Rehberg 2005, Fadely *et al.* 2005) and most locations at sea are associated with onshelf waters <100 m deep (Fadely *et al.* 2005). Previous researchers have found that trip distance and duration increases significantly with age and there also tends to be a marked increase in trip distance, trip duration, and haulout use once juveniles reach 10 months of age (Loughlin *et al.* 2003, Raum-Suryan *et al.* 2004). Telemetry studies have indicated that pups are capable of traveling 120 km from their natal rookery by the age of 2 months (Raum-Suryan *et al.* 2004) and brand resight studies have indicated that pups are capable of traveling more than 400 km by 5 months of age (Raum-Suryan *et al.* 2002). Juveniles (females: 1 - 2.9 years, males: 1 - 4.9 years) tend to disperse greater distances than pups (max = 1,785 km from natal rookery; Raum-Suryan *et al.* 2002) and their swimming ability is comparable to that of adults (Loughlin *et al.* 2003). Trip distance does not differ between sex (Loughlin *et al.* 2003, Raum-Suryan *et al.* 2004), but most long-range trips (500 to 1300 km) have been documented for males rather than females (Loughlin *et al.* 2003, Raum-Suryan *et al.* 2004). Interestingly, Raum-Suryan *et al.* (2004) reported that females had a significantly greater geometric mean trip duration ($\bar{x}$ = 2.7 h, 95% CI = 2.37, 3.03) than males ($\bar{x}$ = 2.2 h, 95% CI = 1.91, 2.52) and suggested females either were more selective than males when searching for prey or they had to spend more time attaining prey resources because they had less diving capabilities than males.

3.1.10.3 Development of Diving Ability

Knowledge of the progression of diving ability in relation to age is important for understanding the weaning and independent foraging strategies of pinnipeds (Pitcher *et al.* 2005). Overall, studies have indicated that dives of juvenile Steller sea lions are short and shallow Merrick and Loughlin 1997, Loughlin *et al.* 2003, Pitcher *et al.* 2005, Rehberg 2005). Merrick and Loughlin (1997) satellite-tagged 5 young-of-the-year (YOY) and 15 adult female Steller sea lions from the central Gulf of Alaska through the eastern Aleutian Islands and found that YOY Steller sea lions exerted less foraging effort and made shorter, shallower dives than adult females. However, older juveniles dove more frequently and deeper and spent more time at sea than younger juveniles. Because YOY sea lions were diving within their calculated aerobic dive limit (cADL; 3.9 to 5.2 min) and did not appear constrained physiologically, Merrick and Loughlin (1997) suggested that it may require time for young sea lions to develop appropriate diving behaviors and knowledge of prey resources during development. Although Richmond *et al.* (2006) calculated a similar range of cADL values for juveniles; they suggested juveniles were constrained physiologically because they were consistently diving at the upper range of their aerobic scope.

During a dive, approximately 47% of a sea lion's oxygen stores are in blood, with 35% in muscle and the remainder in the lungs (Kooyman 1985). There is a considerable developmental component until the oxygen storage ability of an otariid is fully matured (Horning and Trillmich 1997), because of increases in blood volume, muscle myoglobin and body mass. Likewise, juveniles operate at metabolically higher rates than adults (Lavigne *et al.* 1986, Costa 1993). Thus, younger sea lions do not have the same capacity to stay submerged (and hence dive to as great of depths) as adults, which consequently affects their ability to acquire prey and thus choice of foraging strategies.

Loughlin *et al.* (2003) used a combination of satellite-linked time-depth recorders (SLTDRs) and satellite depth recorders (SDRs) to monitor the diving behavior of juvenile Steller sea lions and found that mean dive depth and duration did not differ between males and females, but both parameters displayed an ontogenetic trend. For example, 7-10 month old sea lions tagged in Alaska typically had a mean dive duration of <1 minute and a mean dive depth of approximately 10 m. However, these parameters nearly doubled by the time sea lions reached one year of age (11 to 12 months) when they appeared to be as capable as adults in their movement and diving behavior (Table 3.13). Changes in diving activity likely correspond to an increase in Hct, Hb, and blood oxygen stores, which are also similar to adults at approximately 9 months of age (Richmond *et al.* 2005, 2006). The oxygen-carrying capacity of muscle also increases with age and appears similar to adult females at approximately 17 months of age (Richmond *et al.* 2006). Pitcher *et al.* (2005) documented the ontogeny of diving performance of pups (<1 year of age) and juveniles (1-3 years of age) using SDRs and reported that YOYs (i.e. 6 months) were capable of diving to nearly 100 m, yearlings were capable of diving to 200 m, and older juveniles (i.e. 3 years) were capable of diving to depths greater than 400 m. On average, females appeared to dive deeper than males as they became older, but durations of dives were longer for males (Pitcher *et al.* 2005). Mean dive duration increased with age, with maximum mean durations reaching approximately 4 minutes by 1 year of age, 5 minutes by 2 years of age, and 6 minutes by 3 years of age. Fadely *et al.* (2005) observed similar trends for 30 (*n* = 11 males and 19 females) immature Steller sea lions (5 to 21 months of age) tagged with SDRs in the eastern Aleutian Islands, but also found that time at depth (TAD), and dive rate (number of dives per time spent at sea within a 6 hour period) increased throughout the first 17 months of age. An increase in diving activity also coincided with increases in sea surface temperature and chlorophyll-a. Age differences in diving activity were more evident during winter months when juveniles dived more frequently, deeper, and spent more TAD than did pups. However, between 1-2 years of age there was an apparent leveling of dive ability as measured by dive rate and TAD.

Sea lions have a streamlined shape that minimizes the cost of transport while swimming (Feldkamp 1987, Stelle *et al.* 2000) and one study identified Steller sea lions as being among the most "maneuverable marine mammals in terms of turning radii in relation to swimming speed" (Cheneval et al. 2006). Laboratory measurements of swim speed and drag in 3 year old Steller sea lions showed that they preferred to swim at a mean velocity of 3.41 m s-1 (2.9-3.4 m s-1), equivalent to 1.46 body lengths per second (Stelle *et al.* 2000), a speed found to be the minimum cost of transport for California sea lions (Feldkamp 1987). Williams *et al.* (1991) found that the average ventilation time did not change with swim speed in California sea lions. That is, time spent submerged did not change as swim speeds increased to 4.37 yd s-1 (4 m s-1). Because of anatomical adaptations, sea lions appear to require shorter times for lung tidal volume exchange than do seals (Williams *et al.* 1991). Skeletal muscles of pinnipeds (and sea lions) are adapted for aerobic metabolism of lipids during hypoxic conditions of diving and exercise (Kanatous *et al.* 1999). Lipid stores in swimming muscle were sufficient to meet the resting muscle metabolism for 17 hours in Steller sea lions (Kanatous *et al.* 1999).

3.1.10.4 Adult Females

Steller sea lions are sexually dimorphic with males being considerably larger (2-3 times) than females. Female Steller sea lions grow to an average of 2.3 m (max = 2.9 m) and weigh an average of 263 kg (max = 350 kg; Loughlin 2002). Thus, it is not surprising that adult females have significantly lower mass specific oxygen stores and total body oxygen stores than adult males. Furthermore, the cADL of adult females (7.5 minutes) is less than that of adult males (12.0 minutes; Richmond *et al.* 2006). Female Steller sea lions reach sexual maturity anywhere from 3-8 years, may breed into their early twenties, and may live for as much as 30 years. The ability to give birth at 3 years of age appears to be unusual, but has been documented a few times (Pitcher and Calkins 1981, Raum-Suryan *et al.* 2002). For example, branded females from 3 to 22 years of age have been observed with pups. Adult females appear to exhibit fidelity to specific areas and rookeries (Calkins and Pitcher 1982, Merrick *et al.* 1995, Raum-Suryan *et al.* 2002) and have been observed to pup at their natal rookery (Raum-Suryan *et al.* 2002).

Due to logistics associated with capturing and handling adult females, there is limited information pertaining to the foraging ecology of this age class. Merrick et al. (1994) deployed a SLTDR on one adult female near Kodiak, Alaska and one adult female from Akun Island, Alaska. Average dive depths for the two animals were 36.5 m (max = 164 m) and 42.9 m (max = 198 m), mean dive durations were 2.4 min (max = 6.0 and 11.0 min), and mean surface intervals (time spent at the surface) were 4 minutes (max = 42.2 and 160.0 min). Both females foraged within 20 km of land during summer, made brief trips (<2 days), and dove to shallow depths (<30 m). During winter, dives were deeper (often >250 m) and trips were greater in distance (as much as 300 km) and duration (up to several months). Similarly, Merrick and Loughlin (1997) satellite-tagged 15 adult female Steller sea lions from the central Gulf of Alaska through the eastern Aleutian Islands and found that adult females spent more time at sea, dived deeper, and had greater home ranges during winter than they did during summer. These behaviors may have reflected reproductive status or changes in prey availability and distribution resulting from seasonal variability (Merrick and Loughlin 1997). Foraging behaviors of 8 adult females in Russia were similar to those in Alaska (Loughlin *et al.* 1998). Although one female traveled a distance of 263 km, 94% of all locations at sea were within 10 km of the island of capture. Overall, diving behavior varied among individuals, but dive depths were shallow and dive durations were short.

To investigate the nutritional stress hypothesis, Andrews *et al.* (2001) used stomach temperature telemetry and satellite telemetry to monitor the behavior of 4 lactating Steller sea lions from the central Aleutian Islands (Seguam and Yunaska) and 5 lactating sea lions from areas near Forrester Island, Southeast Alaska. Similar to previous studies, foraging behavior varied among individuals, but metabolic rates and the percent of time spent submerged while at sea were similar between the two groups. However, the times spent at sea, trip durations, trip distances, and mean times from departure to first prey ingestion for females from the Aleutian Islands were shorter than those for females from Southeast Alaska. Additionally, dives performed by sea lions from the central Aleutian Islands were shorter and shallower, but more frequent than those by sea lions from Southeast Alaska. Because fish surveys of the two areas were conducted simultaneously with data collection for sea lions, Andrews *et al.* (2001) were able to demonstrate a correlation between prey availability, foraging success, and pup growth.

In captive studies, Steller sea lions (*Eumetopias jubatus*) fed restricted diets for up to 9 days during spring, summer, fall, and winter lost an average of 10% of their initial body mass. We tracked changes in the levels of three hormones (cortisol, total thyroxine—TT4, total triiodothyronine— TT3) and one blood metabolite (blood urea nitrogen—BUN) following a food restriction in relation to season, body mass, body composition, and metabolism. Degree of changes in cortisol, TT3, and BUN after food restriction was signicantly affected by season. The greatest changesin cortisol (+231%), BUN (+11.4%), TT4 (23.3%), and TT3 (35.6%) occurred in the winter (November/December) when rates of body mass loss were also greatest. Changes in cortisol levels were positively related to total body mass loss, while changes in TT3 levels were negatively related. While greater increases in BUN were related to greater rates of mass loss, the use of BUN levels as an indicator of metabolic state is complicated by the type and level of food intake. The observed changes in hormone levels support morphological data suggesting Steller sea lions may be more strongly impacted by short-term, reduced energy intake during winter than at other times of the year.

With the development of new capture techniques, additional insight into the foraging ecology of adult females may be obtained in the future.

3.1.11 Foraging Ecology – Integration and Synthesis

Foraging patterns of Steller sea lions are still far from being completely described, especially for older juveniles (age 2-4) and adult females. However, the available information suggests that:

- Steller sea lions are land-based predators but their attachment to land and foraging patterns/distribution varies considerably as a function of age, sex, site, season, and reproductive status, and as a function of prey availability and environmental conditions.

- Steller sea lions tend to be relatively shallow divers but are capable of (and apparently do) exploit deeper waters (e.g., to beyond the shelf break).

- Foraging sites relatively close to rookeries may be particularly important during the reproductive season when lactating females are limited by the nutritional requirements of their pups.

- Pups dependent upon mothers for nutrition tend not to disperse greatly and remain relatively nearshore conducting shallow dives.

- Yearlings that have likely reached nutritional independence greatly increase their foraging area, and begin deeper diving.

- Food availability is important year-round, but particularly during the fall/winter for adult females (especially lactating females) when pregnancy increases energetic demands, and winter/spring for juveniles that are transitioning to nutritional independence.

- Dominant prey items vary with region and season, but pollock, Atka mackerel, Pacific cod and salmon are generally the most common or dominant prey.

- Steller sea lions consume a variety of demersal, semi-demersal, and pelagic prey, indicating a potentially broad spectrum of foraging styles probably based primarily on availability.

- Diet diversity may influence status and growth of Steller sea lion populations.

- The life history and spatial/temporal distribution of important prey species are likely important determinants of sea lion foraging success.

- The broad distribution of sea lions sighted in the POP database and through satellite telemetry indicates that sea lions forage at sites distant from rookeries and haulout sites.

- The availability of prey at these sites may be crucial in that they allow sea lions to take advantage of distant food sources, thereby mitigating the potential for intraspecific competition for prey in the vicinity of rookeries and haulout sites.

For a foraging sea lion, the net gain in energy and nutrients is determined, in part, by the availability of prey or prey patches it encounters within its foraging distribution. Competition occurs if the fisheries reduce the availability of prey to the extent that sea lion condition, growth, reproduction, or survival is diminished, and population recovery is impeded.

3.1.12 Infectious Disease and Toxic Substances

Disease is a natural process and is the mechanism by which many animals die. The important question for Steller sea lions is whether disease agents currently have the potential to prevent or slow recovery through increased mortality or decreased reproductive output. Disease may be caused by many factors, including pathogens of viral, bacterial, protozoan, or fungal origins, which are either known to Steller sea lions and related species or are unknown to Steller sea lions but zoonotic. Disease can also occur due to abiotic factors.

Currently there is not evidence indicating that infectious disease caused the decline of Steller sea lions, or is currently having an effect large enough to impede recovery. However, available evidence indicates that the potential for such population-level impacts exists. While infectious disease occurs naturally in all animal populations, it occasionally can result in mortality levels large enough to have population consequences. For example, Härkönen et al. (2006) summarized that phocine distemper virus (PDV) caused two epidemics in waters off of Northern Europe resulting in the deaths of an estimated 23,000 European harbour seals in 1988 (Dietz et al. 1989, Heide-Jørgensen *et al.* 1992) and more than 30,000 deaths in 2002 (Harding et al. 2002, .Jensen et al. 2002). Other marine mammal species have been affected by infections of other viruses, such as canine distemper virus and dolphin morbillivirus (Härkönen et al. 2006). However, in other cases, evidence of exposure to an infectious disease agent was present, but no elevation of mortality was detected. Second, several pathogens are known to result in reproductive loss, either through spontaneous abortions (e.g., *Brucella*) (Brown and Bolin 2000), embryonic or fetal resorption, or through rendering the female infertile. Both epidemics and widespread reproductive dysfunction could result in population level impacts.

Burek et al. (2006) reviewed and compared available serological data from published and unpublished sources, as well as from more recent (1997-20000) collection to determine if there was evidence indicating that infectious disease may have contributed to the decline of Steller sea lions in the western DPS. Data from the western DPS was compared with that from the eastern DPS. These authors (Burek et al. 2006:512) summarized that “Prevalences of antibodies from the 1970s to the early 1990s were noted for Leptospira interrogans, Chlamydophila psittaci, Brucella spp., phocid herpesvirus-1, and calciviruses. Serum samples collected from 1997-2000 were tested for antibodies to these agents as well as to marine mammal morbilliviruses, canine parvovirus, and canine adenovirus-1 and -2. Conclusions could not be drawn about changes in antibody prevalence to these agents during the decline of Steller sea lions…because data were incomplete or not comparable as a result of inconsistencies in testing techniques…results provided no convincing evidence of significant exposure of Steller sea lions to morbilliviruses, Brucella spp., canine parvovirus, or L. interrogans. Steller sea lions have been exposed to phocid herpesviruses, caliciviruses, canine adenovirus, and C. psittaci or to cross-reactive organisms in regions of both increasing and decreasing sea lion abundance.” Because the estimated antibody prevalence was similar between the eastern (increasing) and western (decreasing at the time of sample collection), they concluded that these agents are unlikely to have been the primary cause of the population decline but may have contributed to it or may impede recovery. Additional detail from studies in which samples from Steller sea lions were tested for exposure to infectious disease agents are in earlier papers [e.g., regarding phocid herpesvirus, and phocine and canine distemper viruses: (Barlough *et al.* 1987, Zarnke *et al.* 1997, Sheffield and Zarnke 1997); morbilliviruses, canine parvovirus, Brucella, Toxoplasma, and influenza A (Sheffield and Zarnke 1997, Burek et al. 2003)]. Examination and necropsy of dead Steller sea lions has shown some occurrences of hepatitis, Chlamydia, myocarditis, endometritis, tumours, and pneumonia (Gerber *et al.* 1993).

Recently, Goldstein et al. (2009) confirmed the presence of phocine distemper virus (PDV) in wild caught and salvaged sea otters in areas of PWS, the Kodiak Archipelago and the eastern Aleutian Islands. Sea lions are now vulnerable to potential exposure to this virus. As discussed above, evidence from the North Atlantic indicates the effects of exposure to PDV have ranged from large scale epidemics in Atlantic harbor seals to no detectable population impacts in other species.

Several of the disease agents to which sea lions have been exposed are known to affect reproduction in other species. Alaskan Steller sea lions have been exposed to two types of bacteria, Leptospira and Chlamydia (Calkins and Goodwin 1988, Sheffield and Zarnke 1997, Burek *et al.* 2003), and one virus, the San Miguel sea lion virus, that have caused reproductive problems in other species.   San Miguel Sea Lion Virus and Leptospira have been associated with reproductive failures or neonatal deaths in California sea lions and northern fur seals (Smith *et al.* 1974, Gilmartin *et al.* 1976). Virtually nothing is known about the possible effects of Chlamydia on pinnipeds, but in other animals Chlamydia is known to cause abortion, stillbirths, and production of weak young (Shewen 1980).

Parasites of Steller sea lions include intestinal cestodes; trematodes in the intestine and bile duct of the liver; nematodes in the stomach, intestine, and lungs; acanthocephalans in the intestine; acarian mites in the nasopharynx and lungs; and an anopluran skin louse (Dailey and Hill 1970, Dailey and Brownell 1972, Fay and Furman 1982, Shults 1986, Gerber *et al.* 1993). The potential for parasitism to have a population level affect on sea lions is largely unknown. Whereas parasites may have little impact on otherwise healthy animals, effects could become significant if combined with other stressors (Haebler and Moeller 1993). Available information does not suggest that the sea lion decline was caused by parasitic infections, although there has not been adequate research to assess the relative nature and magnitude of parasitism in sea lion populations. Investigations of parasites require necropsy of relatively fresh carcasses and these only occur on a sporadic basis on beach cast animals.

Environmental contaminants can cause death, acute illness or chronic impacts. For example, acute toxicity caused by a major point source of a pollutant (such as an oil spill or hazardous waste) can sometimes rapidly lead to mortality or can cause grave health problems in exposed animals due to damage to neurological, digestive and reproductive systems. Chronic effects can be manifested through complex biochemical pathways that suppress immune functions and disrupt the endocrine balance of the body, causing poor growth, development, reproduction and reduced fitness. Contaminants of particular concern include organochlorines (OCs; mainly PCBs and DDTs), the commonly called "heavy metals", and polycyclic aromatic hydrocarbons (PAHs). There are also a number of "emerging" contaminants, e.g., flame retardant polybrominated diphenyl ethers (PBDEs), which could also be impacting marine mammals (de Wit *et al.* 2002).

Aside from the Exxon Valdez Oil Spill in 1989, which occurred well after the Steller sea lion decline was underway, no other events have been recorded that support the possibility of acute toxicity leading to substantial mortality of Steller sea lions (Calkins *et al.* 1994). However, results from several studies, both published and still being conducted, do not permit the complete rejection of toxic substances as a factor that may currently impact sea lion vital rates. These studies have been conducted on both Steller sea lions and other pinniped species and are briefly reviewed below by toxin category.

Sea lions exposed to oil spills may become contaminated with PAHs through inhalation, dermal contact and absorption, direct ingestion, or by ingestion of contaminated prey (Albers and Loughlin 2003). After the Exxon Valdez oil spill, Calkins *et al.* (1994) recovered 12 Steller sea lion carcasses from the beaches of Prince William Sound and collected 16 additional Steller sea lions from haul out sites in the vicinity of Prince William Sound, the Kenai coast, and the Barren Islands. The highest levels of PAHs were in animals found dead following the oil spill in PWS. Furthermore, sea lion bile samples collected seven months after the spill had levels of PAH metabolites consistent with exposure to PAH compounds (Calkins *et al.* 1994). However, histological examinations found no lesions that could be attributed to hydrocarbon contamination (Calkins *et al.* 1994).

OC contaminant exposure in marine mammals and other wildlife has been associated with reproductive failures (Helle *et al.* 1976, Reijnders 1986), population declines (Martineau *et al.* 1987), carcinomas (Martineau *et al.* 1999, Ylitalo *et al.* 2005), and immune suppression (de Swart *et al.* 1994, Ross *et al.* 1996; Beckmen *et al.* 2003). No toxicological studies have been performed on Steller sea lions to determine possible effects of OC contaminants. However, OCs that cause health impacts in other species have been measured in subsets of Steller sea lion populations from Japan, the Russian far east, Aleutian Islands, Pribilof Islands, Gulf of Alaska and Southeast Alaska (Lee *et al.* 1996, Varanasi *et al.* 1992, Hoshino *et al.* 2006, Hong *et al.* 2005, Myers 2005). PCB congener levels in 4 out of 10 sea lions near Hokkaido and 2 out of 12 near Olyutorsky Bay (Kamchatka) (Hoshino *et al.* 2006) exceeded the levels in ribbon seals with decreased circulating thyroid hormones (Chiba *et al.* 2001). However, none of the sea lions in a study by Hoshino *et al.* (2006) exceeded the levels of PCBs in harbor seals that experienced immune suppression (de Swart *et al.* 1996). Furthermore, Steller sea lions may not have the same sensitivity to toxic PCBs as do ribbon seals. Thus, the ultimate effect of PCB toxicity on sea lion fitness is unknown. Heintz *et al.* (2006) investigated OCs in a primary Steller sea lion prey item (pollock) through much of the range of Steller sea lions in Alaska. They found higher concentrations of OCs in pollock in southeast Alaska, within the range of the eastern DPS, but also found OCs to be ubiquitous throughout their sampling area. Given that the eastern DPS has been increasing (e.g., recovering) while consuming prey with higher OC concentrations, OCs may not be the primary factor for recent declines in population and natality observed in the western DPS.

Overall, studies on organochlorines suggest a decline in OC concentrations over time, a finding that is consistent with that reported for other wildlife species. OC concentrations in sea lion samples from different parts of the range have differed significantly (Myers and Atkinson 2005, Hoshino *et al.* 2006), although not consistently throughout all studies (Hong *et al.* 2005). In some studies, a few individuals with particularly high concentrations have skewed the mean results, giving high standard deviations that result in non-significant or inconclusive statistical results. The studies that measured more than one OC generally found that the PCB congeners and DDT metabolites were the most prevalent OCs measured in Steller sea lions. No studies have been published that report any PBDE congeners.

Studies from Europe have provided threshold levels of OCs above which immunosuppression or reproductive problems are likely to occur (de Swart *et al.* 1994, Ross *et al.* 1996). Although these studies were conducted on harbor seals, the thresholds are often used for related species such as Steller sea lions. Several individual California sea lions (*Zalophus californianus*) have been sampled that had high concentrations of DDTs and PDBs (Kannan *et al.* 2004), which were linked to physiological impairments (Debier *et al.* 2005) and cancer associated mortality (Ylitalo *et al.* 2005). A threshold for reproductive failures (i.e., spontaneous abortions) has been estimated, based on a mass toxicity event of California sea lions from the 1970's (DeLong *et al.* 1973, Gilmartin *et al.* 1976)

Although publications on the effects of emerging contaminants are few (Barron *et al.* 2003), one class of "emerging" environmental contaminants, the PBDEs, are quickly gaining the attention of regulatory agencies (de Wit *et al.* 2002). These compounds are added to plastics, textiles, clothing, electronic circuit boards and other materials as flame retardants. PBDEs are known to enter the environment through urban runoff and sewage outfalls and have been shown to bioaccumulate in marine animals (de Wit *et al.* 2002). A number of studies have shown that some PBDE congeners may induce toxicological effects in laboratory animals, including immune dysfunction, liver toxicity, thyroid disruption and possibly cancer (de Wit *et al.* 2002, MacDonald 2002). Some data are available on the levels of PBDEs in marine mammals from North America (Ikonomou *et al.* 2002, She *et al.* 2002, Stapleton *et al.* 2006). Another study reported that PBDEs have increased 10- to 100-fold in blubber of harbor seals collected near San Francisco Bay over the last decade (She *et al.* 2002). Because these compounds continue to be used in the U.S. and other regions of the world, the levels measured in marine environmental samples are expected to increase. Ikonomou *et al.* (2002) reported that PBDEs may become the most prevalent POP in arctic ringed seals in the next 50 years. However, few studies have looked at PBDE exposure and associated health effects in marine mammals. Thus, the potential for Steller sea lion exposure to unknown contaminants, such as PBDEs, many of which are increasing, is a significant gap in our understanding of impacts of pollutants on Steller sea lions (Barron *et al.* 2003).

Heavy metals are also contaminants of concern. Heavy metal concentrations measured in Steller sea lion livers were generally much lower than in northern fur seals (Noda *et al.* 1995). For example, mercury levels in the hair of young Steller sea lions from both the western and eastern DPSs were lower than for northern fur seals (Beckmen *et al.* 2002), yet concerns remained about possible effects on fetal development and interactive effects with other contaminants. Castellini (1999) found that zinc, copper, and metallothionien (a chelating compound) levels were comparable between sea lion pups sampled from both the western and eastern DPSs, and were lower than for captive sea lions. Kim *et al.* (1996) reported on the accumulation of butyltin in the liver of Steller sea lions from Alaska and Japan and found much lower levels in the Alaska samples than in those from Japan. These authors also suggested that butyltin degrades rapidly in sea lions and does not bioaccumulate. Although these studies are not comprehensive, they indicate that heavy metals were not likely a significant factor in the decline of the Steller sea lions.

In summary, contaminant risks are largely unknown in Steller sea lions and are little understood in pinnipeds in general (Barron *et al.* 2003). Definitive studies that have causally linked contaminant exposures and adverse effects in pinnipeds have been limited to laboratory studies with PCBs and Hg in dietary studies with captive seals. Field studies with pinnipeds have been confounded with other factors and cannot be unambiguously linked to contaminant caused impacts. The sensitivity of pinnipeds to contaminants relative to the sensitivity of other species is largely unknown. Thus, adverse effect levels of contaminants in Steller sea lions must be inferred from studies in other species (Barron *et al.* 2003). As a result, the primary data gap is an understanding of what levels of contaminants affect sea lion health, and subsequently also affect vital rates, especially reproduction. Further, the possible effects on reproduction from chronic exposure to relatively low concentrations of toxic substances and the potential for reactive metabolites to cause damage to target tissues must be understood to be able to relate observed toxin levels to population effects in the western DPS of Steller sea lion.

3.1.13 Predators

Steller sea lions are eaten by transient killer whales (*Orcinus orca*) in both the western and eastern DPSs. The available information on transient killer whale populations and feeding ecology within the range of Steller sea lions and the likely impact of killer whale predation on sea lions is discussed in depth in Chapter 4.

Sharks represent another potential predator that may attack Steller sea lions. Although white shark predation on North Pacific pinnipeds has been well documented (LeBoeuf *et al.* 1982, Ainley *et al.* 1985, Long *et al.* 1996), these sharks occur rarely, if at all, in the range of the western Steller sea lion population. Although salmon shark populations have increased since 1990, they are considered piscivorous and have not been reported to prey on Steller sea lions. Another species of large shark, the Pacific sleeper shark (*Somniosus pacificus*), is common in the Gulf of Alaska, Aleutian Islands, and Bering Sea (Orlov 1999). Current indices to sleeper shark relative abundance are based on a recent analysis of sleeper shark bycatch from sablefish longline surveys conducted on the upper continental slope and deepwater gullies of the continental shelf in the eastern Bering Sea, Aleutian Islands, and Gulf of Alaska from 1979-2000 (Courtney and Sigler unpublished data, also see Mueter and Norcross 2002). This analysis indicates sleeper sharks are substantially (about 10x) more abundant in the Gulf of Alaska than in the BSAI region. Further, a significant increase in the relative abundance of sleeper sharks occurred during 1989-2000 in the central Gulf of Alaska, driven largely by the increase of sharks in Shelikof Trough during 1992 and 1993. Most Pacific sleeper shark stomachs that have been examined contained remains of fish and invertebrates (Yang and Page

1998, Orlov 1999), but the remains of harbor seals and porpoises have also been reported (Bright 1959). A recent analysis of sleeper shark stomachs (n=198) collected in the GOA near sea lion rookeries when pups may be most vulnerable to predation (i.e., first water entrance and weaning) found that teleost fishes and cephalopods were the dominant prey (Sigler *et al.* 2006). Tissues of marine mammals were found in 15% of the shark stomachs, but no sea lion tissue was detected. Overall, the study concluded that sea lions are unlikely prey of sleeper sharks, harbor seals are infrequent prey and may be consumed alive, and that cetaceans are a frequent diet item for larger sleeper sharks and commonly scavenged. A companion study documented that shark and sea lion home ranges overlapped (Hulbert *et al.* 2006), and thus the results of these two studies, and others, indicate no scientific evidence presently exists to suggest that sleeper sharks actively prey on Steller sea lions.

3.1.14 Competitors

Steller sea lions forage on a variety of marine prey that are also consumed by other marine mammals (e.g., northern fur seals, harbor seals, humpback whales), marine birds (e.g., murres and kittiwakes), and marine fishes (e.g., pollock, arrowtooth flounder). To some extent, these potential competitors may partition the prey resource so that little direct competition occurs. For example, harbor seals and northern fur seals may consume smaller pollock than Steller sea lions (Fritz *et al.* 1995). Competition may still occur if the consumption of smaller pollock limits the eventual biomass of larger pollock for sea lions, but the connection would be difficult to demonstrate. Such competition may occur only seasonally if, for example, fur seals migrate out of the area of competition in the winter and spring months. Similarly, competition may occur only locally if prey availability or prey selection varies geographically for either potential competitor. Finally, competition between sea lions and other predators may be restricted to certain age classes, because diet may change with age or size. Further discussion of the impacts of competitors is provided in Chapter 4.

3.1.15 Nutritional Stress in Steller Sea Lions

In previous sections we discussed various topics such as sea lion vital rates, nutritional requirements, foraging ecology, prey, etc. In this section we synthesize this information to evaluate the evidence for nutritional stress. Nutritional stress is defined as the result of a species being unable to acquire adequate energy and nutrients from their prey resources. This can be manifested through acute nutritional stress (e.g., emaciation, rapid mortality through starvation, large scale breeding failures) and chronic nutritional stress (e.g, reduction in fecundity, reduced body size, higher juvenile and adult mortality, increased predation risk)(Trites and Donnelly 2003, NMFS 2000).

Inadequate prey intake by Steller sea lions will eventually be manifested at some level as nutritional stress (chronic or acute) with various changes in vital rates (see Bowen *et al.* 2001 NRC 2003. Nutritional stress is a physiological response to suboptimal quantity and/or quality of available food, and may be acute (e.g., starvation occurring over a period of weeks) or chronic (e.g., suboptimal consumption over a period of months or years) (Trites and Donnelly 2003). Nutritional stress has been considered a leading hypothesis to explain the rapid decline of the western DPS of Steller sea lion (NMFS 2000), and has been the subject of considerable debate (NRC 2003, Trites and Donnelly 2003, Fritz and Hinckley 2005). However, it has been a difficult hypothesis to test due to a lack of data for Steller sea lions during the period of decline, the difficulty of working with these animals in remote locations, the long-term nature of the problem, and a poor understanding of the basic nutritional biology of Steller sea lions.

When assessing the potential for nutritional stress in Steller sea lions it is important to distinguish between early and late periods of the decline as well as recent population trends. The decline in the number of Steller sea lions in the western DPS was rapid through the 1980s, but slowed during the 1990s. In terms of testing the nutritional stress hypothesis, this means that the animals currently available in the wild for study may no longer be affected by the factors that caused their initial population decline. Many of the biological indicators of past (or current) nutritional stress may therefore no longer be measurable in direct ways. Nutritional limitation as indicated by reduced body size and reduced late term pregnancy rates during the rapid decline of the 1980s contrasts with recent studies of Steller sea lions from the western DPS. Yet, if survival in the 1980s was greatly reduced, then it is likely that affected animals are under-represented in current samples. Modeling results by Malavear (2004) suggests that juveniles less than one year old may die off fairly rapidly, whereas the older juveniles respond by slower growth and maturation times. Frid *et al.* (2006) suggest that because of interactions between energy status, predation risk and prey availability the body condition of animals could remain high while food resources are indeed declining. The marked acute nutritional effects observed for immature and adult otariids when prey biomass is reduced during El Niño events (Trillmich and Ono 1991, Soto *et al.* 2004) have not been observed for Steller sea lions. Therefore, if nutritional stress is acting on the western DPS, then we must look for evidence for/against chronic nutritional stress as opposed to acute nutritional stress (Trites and Donnelly 2003, Rosen *et al.* 2006).

3.1.15.1 Evidence of Nutritional Stress During The Rapid Decline – The 1980s

Steller sea lions collected in the Gulf of Alaska during the early 1980s showed evidence of reproductive failure and reduced rates of body growth that were consistent with nutritional limitation (Calkins and Goodwin 1988, Pitcher *et al.* 1998, Calkins *et al.* 1998). Lactating females were less likely to become pregnant than non-lactating females during the early decline, indicating that the energetic stress of nursing while being pregnant with another pup may have prevented a significant number of females from giving birth each year (Pitcher *et al.* 1998). During the 1970s and 1980s, 100% and 95%, respectively, of all sexually mature females in the western DPS were pregnant in early gestation. The percentage of those females that carried their pregnancy to late gestation was only 55% to 67% during the 1970s and 1980s and was not statistically different between periods (Pitcher *et al.* 1998). However, among lactating females with higher energy demands, 63% carried their pregnancies to late gestation in the 1970s compared to only 30% in the 1980s, and this difference was significant. Better body condition was found to increase the probability that a female would maintain pregnancy. Comparatively low birth rates for females from the western DPS during the 1970s and 1980s (Pitcher and Calkins 1981) coupled with elevated embryonic and fetal mortality, appear to have contributed to decreased reproductive performance during the period of early decline (Pitcher and Calkins 1981, Calkins and Goodwin 1988, Pitcher *et al.* 1998, NMFS 1998b, 2000). Age-structured models fit to observed time series of pup and non-pup counts suggest that declines in reproductive performance of females in the western DPS continued through the 1990s and into the 2000s within the western DPS (Holmes and York 2003, Fay 2004, Winship and Trites 2006).

Food limitation resulting from the lack of availability of prey, or reduced quality, can result in reduced body size in marine mammals (Scheffer 1955, Laws 1956, Read and Gaskin 1990, Trites and Bigg 1992). Another indication that the western DPS may have been nutritionally compromised during the period of rapid decline in the 1980s was a reduction in average body size (Perez and Loughlin 1991, Castellini and Calkins 1993, Calkins *et al.* 1998). Steller sea lions from the central Gulf of Alaska during the 1980s were smaller in length, girth, and weight compared to the 1950s (Calkins *et al.* 1998, Fiscus 1961, Mathisen *et al.* 1962) and 1970s (Perez and Loughlin 1991, Castellini and Calkins 1993, Calkins and Goodwin 1988). Female sea lions over age 9 in the 1950s were significantly larger (standard length and auxiliary girth) than in the 1970s and 1980s (Calkins *et al.* 1998).

Since body size is influenced most during the first 8 years of life (Calkins and Pitcher 1982), Calkins *et al.* (1998) backdated 8 years from their mid-1980s sample to determine the break point for the reduction in size—the late 1970s, or just after the 1977 regime shift. Ages of sea lions from the 1958 collection (Fiscus 1961, Mathisen *et al.* 1962) ranged from 9 to 22. Backdating 9-22 years from 1958, to see when growth was important to setting the size of the older females collected then, yields 1936-1944 as the critical years for the oldest females and 1949-1957 for the youngest. Thus, female sea lions collected in 1958 grew to large sizes from 1936-1957; this was a period when diets, for at least a portion of the interval, apparently were dominated by gadids and flounders (Imler and Sarber 1947). Applying the same procedure to the size data from the mid-1970s yields 8-year growth intervals of approximately 1959-1967 for the oldest (16 years) and 1968-1976 for the youngest; or from 1959-76 for all ages. The oldest animals underwent their 8 critical growth years during a period of what is thought by some to have been rich in high quality prey (Trites and Donnely 2003), yet they were smaller than those animals from the preceding gadid-rich era of the mid-1940s.

Such a change in morphological indices from animals in the wild (Pitcher *et al.* 2000) is consistent with sub-optimal nutritional status in the 1980s compared with the 1970s. Further, adult females in the 1970s were themselves smaller than in the late 1950s (Calkins *et al.* 1998), indicating that nutritional stress may have occurred prior to the regime shift of the mid-1970s. Sea lions feeding on a gadid-dominated diet in the 1940s appeared larger than in later samples during the 1970s. This is contrary to the prey quality hypothesis for nutritional stress.

3.1.15.2 Evidence for Nutritional Stress During the Slower Decline – The 1990s

Much of the research from 1990-2004 to determine the extent to which nutritional stress (either acute or chronic) could be a factor in the decline of the western DPS Steller sea lions involved comparing individual animals from the western and eastern DPS. Many of the studies focused on pup condition, as well as maternal attendance patterns, foraging biology and adult dietary analyses. Contrary to what would be expected for animals experiencing acute nutritional stress, Steller sea lion pups in the early 1990s were heavier in the areas of population decline (i.e. the western DPS) than in rookeries where the population was increasing (Merrick *et al.* 1995).

Pups at two rookeries within the area of decline were heavier in 1992-93 than prior to the decline in 1965 and 1975. Similar results were reported by Davis *et al.* (1996, 2004) who found no significant differences in pup birth sizes between declining and stable populations in the 1990s; nor were there differences in adult female body mass or composition. After analysis of blood chemistry and hematology in pups less than 1 month of age, Rea et al. (1998:617) found that pups in southeast Alaska had elevated beta-HBA concentrations "…suggesting they underwent lower periods of fasting than seen in pups in other areas." Their findings did not indicate that pups from areas of population decline were nutritionally stressed. Rea *et al.* (2003) found no indication of poor body condition (based on percent total body lipid) in pups from either area. Paradoxically, Adams (2000) found pup growth rates were higher and females were larger by mass and length in declining western DPS areas (see also Brandon 2000).

Using a similar comparative protocol, researchers observed no differences or opposite than expected trends for Steller sea lion milk composition (Davis *et al.*1996, Adams 2000), pup milk intake rates (Adams 2000), pup growth rates (Davis *et al.* 1996, Adams 2000), maternal attendance patterns and foraging trip duration (Brandon 2000, Milette and Trites 2003, Andrews *et al.* 2002) between the western and eastern DPS for Steller sea lions. Results from all of these studies suggest that adult females at rookeries in the declining population did not have difficulty finding prey during the summer. Furthermore, no apparent difference was observed between average winter attendance cycles of females from the declining western DPS (Marmot Island and Cape St. Elias) and increasing eastern DPS (Timbered Island) haul out populations (Trites *et al.* 2006b). In the 21st century, no evidence has yet been found of exceptional pup mortality, low birth weights in the western DPS, or poor growth of pups in the area of decline. Body fat contents were highly variable in both areas at 15 months of age (Rea *et al.* 2003). Fadely *et al.* (2004) compared growth rates of 29 sea lions captured in a longitudinal survey in Alaska from 2000-2003. The growth rates for juveniles were higher in the western DPS than for the eastern DPS.

Blood chemistry and hematological parameters, including blood urea nitrogen (BUN), ketone bodies (e.g., b-HBA), hematocrit and hemoglobin concentration, show characteristic patterns with changes in nutrition (Keyes 1968, Rea 1995), and have been experimentally induced in fasted Steller sea lion pups and juveniles (Rea *et al.* 1998b, Rea *et al.* 2000). However, Rea *et al.* (1998a) found no evidence of nutritional stress based on these parameters in wild Steller sea lions from areas with the greatest population declines. Red blood cell data from a study by Bishop and Morado (1995) reported elevated target cells and depressed poikilocyte levels in pups from the western DPS compared to those in the eastern DPS, indicative of anemia in the western DPS. Conversely, Castellini *et al.* (1993) reported no obvious differences in hematocrit or hemoglobin levels in pups during the 1990s from the western DPS compared to reference values. In evaluating serum haptoglobin levels (an indicator of acute stress response) in Steller sea lions, Zenteno-Savin *et al.* (1997) reported elevated serum levels in the western DPS compared to the east, but were careful to avoid speculation on the cause of these differences.

The general conclusion from these physiological studies comparing the eastern and western DPS during the 1990s has been that acute nutritional stress was not evident in the adult females or pups. Whether this was due to inherent biases in the study design is not known. One potential confounding factor in these studies may be habitat differences between the study sites. This would affect prey aggregation (Lowe and Fritz 1997) and thus foraging times for sea lions (Andrews *et al.* 2002). The large reduction in the western DPS Steller sea lion population by 1990 would likely affect relative prey availability for individuals through reduced competition (Winship and Trites 2003). Despite poor knowledge of the underlying mechanisms, morphological (Williams unpublished data) and survey (Fritz and Stinchcomb 2005) data indicate a trend towards improvement in condition of Steller sea lions in the western DPS relative to conditions in the late 1970s and 1980s, while other demographic evidence (Holmes et al. 2007, Holmes and York 2003, Fay 2004, Fay and Punt 2006) suggests a lingering chronic impact (low fecundity) that could affect the ability of the western DPS to recover.

3.1.15.3 Energetic Demands and the Junk Food Hypothesis

Changes in the structure of fish communities in the North Pacific Ocean (Hollowed and Wooster 1992, 1995, Anderson and Piatt 1999) could alter the quality or availability of prey for Steller sea lions. Alverson (1992) proposed that changes in the structure of the Bering Sea and Gulf of Alaska ecosystems resulted in the dominance of pollock and other gadids (e.g. Pacific cod), and that the shift to ecosystems dominated by pollock had been the overriding factor in the Steller sea lion decline. He suggested a link between the changes in ecosystem trophic structure and the decline of sea lions based on the notion that pollock are a low quality food and the western population of sea lions has not been able to sustain itself with a larger fraction of its diet comprised of pollock. This has become known as the "junk food hypothesis." (Rosen and Trites 2000a, Trites and Donnelly 2003). Initially, proponents of this hypothesis suggested that juveniles and adult females experienced reduced survival and fecundity due to their lower quality, gadid-rich diet.

A number of short-term diet manipulation studies on captive pinnipeds have been conducted to determine the effect of nutritional status on sea lion health. One such study reported that young Steller sea lions raised in captivity did not substantially increase food intake when switched from an ad libitum diet of herring to one of pollock (Rosen and Trites 2000a). The implication from this study was that the captive immature sea lions did not consume sufficient quantities of low-energy fish to maintain energy homeostasis, and thus lost weight during the experiments. A similar finding was reported for immature harp seals (Kirsch *et al.* 2000). When mature harbor seals were switched from high-fat herring to low fat herring, there was no difference in digestibility values, suggesting that digestibility may be more dependant on prey species and less dependant on nutrient composition of any particular type of prey (Stanberry 2003). In addition this harbor seal study showed that adult harbor seals can maintain body condition and health over a short period on a low-fat diet, mainly by slightly increasing their food intake (Stanberry 2003). Fadely *et al.* (1994) found that California sea lions maintained mass equally well on a diet of pollock or herring.

The maximum weight that a Steller sea lion can digest per day on a sustainable basis appears to be about 14-16% of their body mass (Rosen and Trites 2004). This finding is based on offering 1-2 year old captive Steller sea lions as much high-energy (herring) or low-energy (capelin) fish as they could eat every day, or every second day. In this study, young sea lions feeding on low energy prey needed to consume more fish than they were physically capable of to meet their energy requirements. In contrast, older sea lions could consume the extra calories required without hitting the upper ceiling on digestive capacity. This was due in part to the lower relative energy needs of the older sea lions compared to young animals (Winship *et al.* 2002). Rosen and Trites (2002, 2004, 2005) found that Steller sea lions could alter their food intake in response to short-term changes in prey quality or availability and that food restrictions are likely to result in a "foraging response" rather than a "fasting response" which could produce a higher net energy deficit than first suspected (Rosen and Trites 2005). A diet composed of predominantly low energy prey combined with an interrupted schedule of feeding (i.e. on alternate days) necessitated food intake levels that apparently exceeded the physiological digestive capacities of young animals (Rosen and Trites 2004). Rosen *et al.* (2006) also found that sea lions can alter food intake levels to account for lower energy density prey but that juveniles may be more susceptible to these changes as well as reduced availability of prey given their consumption requirements. Calkins *et al.* (2005) conducted feeding experiments with 3 juvenile sea lions and concluded that sea lions were able to compensate for lower quality prey (similar to results in Rosen *et al.* 2006) but without reaching satiation as described by Rosen and Trites (2004).

In comparison to adults, juvenile Steller sea lions on a constant "maintenance" level diet of either pollock or herring for 5 weeks over several seasons demonstrated marked seasonal effect on both body mass and composition (Rosen and Trites 2002, Kumagai 2004, Kumagai *et al.* 2006). Sea lions maintained on a low-lipid pollock diet lost significantly more body lipid reserves during periods of high-energy utilization (i.e., growth) than animals on a high-lipid herring diet. Similarly, juvenile Steller sea lions on calorically equivalent, sub-maintenance diets of low lipid Atka mackerel showed a greater reduction in lipid reserves than when fed sub-maintenance quantities of high lipid herring (Rosen and Trites 2002, 2005). While the sea lions fed Atka mackerel lost more of their lipid energy reserves, the sea lions fed herring lost more lean body mass (e.g., muscle). If sea lions in the wild are similarly restricted in their energy intake, it could have detrimental effects on individual fitness regardless of the prey type. However, these theoretical effects remain to be demonstrated in free-ranging populations which do not have mono-specific diets. Low diet diversity may play a role in nutritional stress but reported relationships between the level of population decline and diet diversity has been questioned (Atkinson et al. 2007 and references cited therein). Rosen and Kumagai (2008) found that sea lions that were fed restricted diets for up to 9 days during spring, summer, fall, and winter lost an average of 10% of their initial body mass. By tracking changes in the levels of one blood metabolite (blood urea nitrogen (BUN) and three hormones (cortisol, total thyroxine—TT4, total triiodothyronine— TT3 following a period of food restriction in relation to season, body composition, body mass, and metabolism, they documented that the degree of changes in cortisol, TT3, and BUN after food restriction was significantly affected by season. In this study, both rates of body mass loss and changes in cortisol (+231%), BUN (+11.4%), TT4 (23.3%), and TT3 (35.6%) were greatest in the winter (November/December). The authors concluded that "

> "The observed changes in hormone levels support morphological data suggesting Steller sea lions may be more strongly impacted by short-term, reduced energy intake during winter than at other times of the year."

The duration of nutritional limitation, age of the animals, seasonal changes in energetic demands and effects of captivity appear to be important factors when evaluating the effects of diet on pinniped physiological responses. The aforementioned studies involved relatively short-term (2-6 week) changes in the diets of juvenile pinnipeds held in permanent captivity. Calkins et al 2005) evaluated the effects of diet on free-ranging juvenile sea lions held in temporary captivity. One group of seven 1-2 year old sea lions was fed only pollock while another group of eight was fed a mixed diet composed primarily of herring for 2 months. All animals gained weight on both diets, and there were no significant differences in the rate of mass increase between the two groups, nor were there any negative health consequences detected in the treatment (pollock) group. In a four-month study of juvenile and adult harbor seals, Trumble *et al.* (2003) found no overall changes in body mass or composition attributed to ad libitum pollock/herring diet changes. The longest study conducted to date was by Castellini (2002) and Calkins *et al.* (2005) and evaluated three different diets on three sea lions over a three-year period. The diets were designed to reflect the pre- and post-decline diets in the Kodiak area and that of sea lions in Southeast Alaska where the population has increased. Changes in body mass of one adult male and two adult females were not significantly different on the three diet regimes, which led the authors to conclude that sea lions could compensate for low energy prey by increasing their ingestion provided sufficient quantity was available. They found that changing seasonal physiology is likely to have more impact on body condition than quality of prey, provided sufficient quantities are available (Calkins *et al.* 2005)

Despite the differences in study designs and limited sample sizes, concurrence is developing between the various captive animal feeding trials on some points. For example, data indicate, and there is widespread agreement that adult sea lions can compensate for lower energy prey by increasing the amount of food they eat. It appears that there are no differential effects between high-lipid and low-lipid (or low-protein and high-protein) prey on sea lion body composition when animals are able to consume sufficient prey to meet their energy demands. Therefore, gadids (primarily Pollock) may have been an important component of a healthy sea lion diet for decades (Calkins et al. 2005, Fritz and Hinckley 2005). Nutritional stress may result from the inability of sea lions to acquire sufficient prey to meet the energetic demands, especially during reproduction or seasonal growth. Juveniles are susceptible to nutritional stress due to their high metabolic requirements, potential consumptive limitations as reported by Rosen and Trites (2003), and limited foraging abilities. Females during the summer breeding season (on rookeries) appear to be able to attain adequate energy to nurse their pups. However, pregnant females with and without pups may be experiencing chronic nutritional stress after leaving the rookery, as evidenced by decreased pregnancy rates of lactating females (Pitcher *et al.* 1998), and decreased natality rates overall (Holmes and York 2003, Fay 2004, Holmes et al. 2007).

3.1.15.4 Correlation of Diet Studies with Wild Steller Sea Lions and Other Otariids

Low energy prey such as pollock or capelin is part of normal Steller sea lion diets. Winship and Trites (2003) concluded that the key difference between the diets of increasing and decreasing sea lion populations in the North Pacific is the overall amount of low energy prey consumed by sea lions in each region (i.e., the average energy density of each meal). Dietary data available for the 1990s (Sinclair and Zepplin 2002) further indicates that higher rates of population decline correlated with meals that had overall lower energy densities. However, pollock makes up a significant portion of the diet of increasing populations of sea lions in Southeast Alaska (Trites *et al*. 2006d), and Pacific hake (*Merluccius productus*) is dominant in the diet of sea lions in Oregon (Riemer and Brown 1997). Furthermore, several stable and increasing populations of otariids including California sea lions (Bailey and Ainley 1982, Riemer and Brown 1997, Gearin *et al.* 1999), Cape fur seals (Punt *et al.* 1995), and South American sea lions (Dans *et al.* 2004) have diets with a high proportion of relatively low energy prey (e.g., gadids).

3.1.15.5 Research Challenges

A critical challenge for Steller sea lion researchers is demonstrating the mechanistic links between prey availability, nutritional stress of the individual, and changes in survival and reproductive rates that would lead to population level effects. The effects of nutritional limitations range from morphological, physiological, and behavioral changes to alterations in vital rates that would affect population trends. A comparison of how these effects may have changed across the 1980s, 1990s, and 2000-2004 identifies many of the data gaps that need to be filled to assess current nutritional status for the western DPS of Steller sea lions. For most categories, available data sets are of such limited geographical and temporal scope that evaluating the role of nutritional stress in the decline of Steller sea lion populations or in its recovery has been hampered. For example, other than numbers of individuals from population counts, no measurements have been made for adult Steller sea lions in the Alaska portion of the western DPS since the 1990s. Consequently, changes in body condition, reproductive success or foraging parameters that would be direct indicators of acute or chronic nutritional stress are currently unknown for adults, except for those estimated by demographic models (York 2003, Fay 2004, Fay and Punt 2006, Holmes et al. 2007).

To date, the focus of nutritional research has been on the effects of nutritional status on individual sea lion behavior, health, and physiology. Proximate dietary mechanisms under investigation include: 1) decreased energy intake due to changes in the availability or energy content of prey, 2) changes in the energy requirements of the predator, 3) deficiency of other nutrients (i.e., protein or specific aminoacids) or essential elements, 4) physiology of metabolic homeostasis, and 5) assessment of nutritional stress responses for different age classes. Part of the difficulty in assessing chronic nutritional stress lies in determining the temporal or spatial scale of study: i.e., how does system wide or localized availability of prey affect Steller sea lion foraging ecology?

The evaluation of body condition in adult Steller sea lions remains problematic due to the inability to safely capture large animals, difficulty of working in remote locations, and poor knowledge of natural variation in body condition that occurs between seasons, geographical region, age, and gender. Indices of body condition include body mass, standard length, auxiliary girth and additional girth rings, and percent body fat. Good evidence exists for losses in body mass during complete fasting in captive animals, but there are difficulties associated with the criterion of body mass in a sexually dimorphic species. The sexes must be examined separately in each geographic area, and longitudinal data (e.g., mean growth rates of branded pups recaptured as juveniles) should be examined. Steller sea lions lose body fat while fasting, but there are also problems peculiar to each of the methods used to measure blubber reserves (direct measure, ultrasound, skinfold calipers, isotope dilution, and bioelectrical impedance analysis).

A series of critical data gaps exist regarding the determination of 1) whether rates of natality have indeed continued to decline 2) whether this decline is due to reduced prey biomass, abundance, and nutritional stress, and 3) how females respond to nutritional stress in their relative energy expenditures on lactation, pregnancy and their own maintenance. Declines in fecundity estimated in the 1990s at a few rookeries were significant (about 30%; Holmes and York 2003, Winship and Trites 2006a), but the mechanisms involved (e.g., nutritional stress, disease contaminants) are unknown.

3.1.15.6 Summary of Nutritional Stress

Sea lions in the 1970s and 1980s exhibited possible symptoms of nutritional stress (Calkins *et al.* 1998, Pitcher *et al.* 1998, Trites and Donnelly 2003), but there is no comparable evidence that nutritional stress was responsible for the continued decline of the western DPS during the 1990s. This may be due in part to differences in methodologies between decades, and the focus on comparing increasing and decreasing populations of sea lions during the 1990s rather than comparing pre- and post-decline conditions.

In terms of acute nutritional stress, there is no indication at any time (1970s–2005) of emaciated juveniles or adults, of a decrease in pup body size, or of lactating females spending more time searching for prey (Table 3.24). However, total birth rates at some rookeries and overall survival rates appeared to be lower during the 1990s. This and a well-documented continued drop in the number of pups and adults counted through the 1990s may have been due to chronic poor nutrition among other causes. The 1990s data suggest that (1) although diet composition of western animals had not changed, adult females appeared to secure enough food to adequately nurse their pups within the first 4-6 weeks of lactation, and (2) if food limitation was a major cause of continued declines (either through a shortage of prey or a low abundance of high energy prey) it may have affected reproductive performance of adult females. There have not been any adult female Steller sea lions captured and handled since the late 1990's. This was primarily due to a change in focus during the period from 2000 – 2006 on juveniles and on the termination of required permits to handle adult females since 2006.

3.1.16 Summary of Status: Population Projections And Variability

3.1.16.1 Population Variability

Populations change as a function of births, deaths, immigration, and emigration. During the non-reproductive season, some sea lions may move between the western and eastern populations (Calkins and Pitcher 1981), but net migration out of the western population is not considered a factor in the decline. Over the past two decades, the amount of growth observed in the eastern population is equivalent to only a small fraction of the losses in the western population. Thus, the decline must be due primarily to changes in birth and death rates. As mentioned above, modeling (York 1994, Holmes and York 2003) and mark-recapture experiments (Chumbley *et al.* 1997) indicate that the most likely problem leading to the decline in the 1980s was decreased juvenile survival, but lower reproductive success was almost certainly a factor contributing to the slower declines of the 1990s and relative stability observed since 2000 (Holmes and York 2003, Pendleton *et al.* 2006; Holmes et al. 2007). Survivorship of both adults and juveniles has increased since the early 1980s and has contributed to the current relative population stability (Holmes et al. 2007).

These changes in vital rates would likely lead to changes in the age structure which, in turn, may tend to destabilize populations. With declining reproductive effort or juvenile survival, populations tend to become "top heavy" with more mature animals (e.g., the increase in mean age of adult females described by York (1994)), followed by a drop in population production as mature animals die without replacement through recruitment of young females. The extent to which the age structure is destabilized and the effect on population growth rate depends, in part, on the length of time that reproduction and/or juvenile survival remain suppressed. Increased mortality of young adult females may have the strongest effect on population growth and potential for recovery, as these females have survived to reproductive age but still have their productive years ahead of them (i.e., they are at the age of greatest reproductive potential).

Vital rates and age structures can change as a function of factors either extrinsic or intrinsic to the population. The Steller sea lion fits the description of a "K-selected" species of large-bodied, long-lived individuals with delayed reproduction, low fecundity, and considerable postnatal maternal investment in the offspring. These characteristics should make sea lion populations relatively tolerant of large changes in their environment, but also slow to rebound following a large decline in numbers or large changes in the population age structure or natality. Thus, the observed decline of the western population over the past two to three decades is not consistent with the naturally occurring fluctuations expected for a K-selected species, and suggests that the combined effect of those factors causing the decline has been severe. The ability of the population to recover (e.g., to its optimum sustainable population (OSP), to a level allowing down- or delisting under the ESA) and the rate at which it recovers will be determined by the same K-selected characteristics (longevity, delayed reproduction, and low fecundity), as well as its metapopulation structure. Its maximum recovery rate will likely be limited to no more than 8% to 10% annually (based on its life history characteristics and observed growth rates of other Otariids), which means that recovery could require 20 to 30 years, even under optimal conditions. The de-listing criteria in The Recovery Plan (NMFS2008) indicate that a recovered western Steller sea lion population would be one that has increased at a minimum of 3% per year for at least 3 generations (30 years). The metapopulation structure of the western population may enhance or deter recovery. Dispersal of populations provides some measure of protection for the entire species against relatively localized threats of decline or extinction and rookeries that go extinct may be more likely recolonized by sea lions migrating between sites. On the other hand, the division of the whole population into smaller demographic units may exacerbate factors that accelerate small populations toward extinction (e.g., unbalanced sex ratios, Allee effects, inbreeding depression). Such acceleration has been referred to as an "extinction vortex" (Gilpin and Soulé 1986).

Finally, any description of population stability for the Steller sea lion should be written with caution. Over the past three decades (or perhaps longer), we have witnessed a severe decline of the western population throughout most of its range. Our inability to anticipate those declines before they occurred, our limited ability to explain them now, and our limited ability to predict the future suggests the difficulty of describing the stability of Steller sea lion populations.

3.1.16.2 Historic Population Change

There appear to be two very distinct phases in the decline of the western DPS. The population declined about 70% between the late 1970s and 1990, but the initial decline likely began as early as the late 1950s in some areas. The rate of decline in the 1980s was very rapid, reaching about 15% per year during 1985-89. During this period, mortality incidental to commercial fishing was thought to contribute to perhaps as much as 25% of the observed decline. In addition, during that period it was legal for fishermen to protect their gear and catch by shooting Steller sea lions. Unfortunately, adequate records on the magnitude of such takes are not available. Some evidence indicates that animals in this population were nutritionally stressed during this time period, while other sources of mortality (e.g., predation by killer whales, mortality associated with disease) cannot be quantified due to a lack of information. There were distinct differences in the rates and pattern of decline in the six subareas used to monitor this population; eastern Gulf, central Gulf, western Gulf, eastern Aleutians, central Aleutians, and western Aleutians. Therefore, it is possible that several factors were important in driving the population decline during this time period.

In the 1990s, the rate of decline decreased from 15% to 5% per year. This followed further environmental changes in the late 1980s and the implementation of extensive fishery regulations (implemented after the ESA-listing in 1990) intended to reduce direct impacts such as shooting and indirect impacts such as competition for prey. During this decade, Steller sea lions did not appear to be nutritionally stressed to the same extent they were in the 1980s. The primary factors associated with the decline during this period have not been identified. As was the case in the 1980s, the pattern and rate of declines in abundance varied significantly by subregion.

Steller sea lions were first listed as threatened under the ESA in 1990 due to the significant unexplained population declines. This listing conveyed that the species was likely to become endangered within the foreseeable future throughout all or a significant portion of its range. In 1997, the species was separated into western and eastern populations based on genetic and demographic criteria (Loughlin 1997), and the western population was listed as endangered. At the time of this listing, the population was considered to be in danger of extinction in all or a significant portion of its range. Single population PVA models published in the mid-1990s indicated that the western population would be extinct in 100 years if the population trend at that time remained unchanged. Subsequent analyses, particularly those that considered the metapopulation structure, estimated less extinction risk for the western population as a whole because of greater persistence within one or more subregions that showed greater stability through the 1990s. However the critical issue as pointed out in section 3.1.5.3, Demographic modeling is that the outcome of any PVA really centered on how the modelers interpreted the period of steepest decline in the 1980's.

The U.S. portion of the western population continued to decline through the 1990s at about 5% annually. Between 2000 and 2004, the population increased at about 3% per year, with most portions of the range showing signs of recovery. Between 2004 and 2007, the western population is thought to have been stable. The increase and subsequent stability appear to have been driven by increases in juvenile and adult survival, since pup production appears to have declined by approximately one-third since the mid 1970s. Because this population still faces substantial threats, and the period of relative stability is very short compared to the long time period of decline, it is still considered to be at risk of extinction within the next 100 years.

The western population of Steller sea lion sustains some direct mortalities from bycatch in commercial fisheries, subsistence harvest, illegal shootings, and entanglements in fishing gear. These human activities clearly have an adverse affect to individuals in the western population; however, the population-level consequences of these anthropogenic stressors are potentially low compared to competition for prey with commercial fisheries or natural changes in the availability or abundance of prey. Because of the relatively low number of animals (compared to historic observations), the population is considered vulnerable to catastrophic and stochastic events that could result in significant declines, threaten viability, and increase the species' risk of extinction. It is important to note that abundance estimates alone cannot be relied upon as accurate measures of population recovery without a long-term understanding of demographic parameters of the population, variability in the population trends and the effects of natural and anthropogenic stressors on the status of the population.

In the late 1990s and early 2000s NMFS reviewed federally managed groundfish fisheries in Alaska, in a series of consultations under section 7 of the ESA. Two of those consultations resulted in a determination that the commercial fisheries were likely to jeopardize the continued existence of the western DPS of Steller sea lion and adversely modify its critical habitat. Therefore, as required under the ESA, additional conservation measures were implemented to avoid jeopardy and adverse modification. These measures were expected to promote the recovery of Steller sea lions in areas where potential competition from commercial fisheries may have contributed to the population decline. It is plausible that the conservation measures implemented since 1990, particularly those involving reduction in direct mortality, positively contributed to reduction in the rate of decline observed in the 1990s and the relative stability observed since 2000.

3.1.16.3 Reproduction Potential

The Holmes *et al.*(2007) age-structured model provides an estimate of the numbers of female Steller sea lions at each age (through 31 years old) in the central Gulf of Alaska population in 2004 (Table 1). These are females that will almost exclusively breed on rookeries at Chirikof, Chowiet, Marmot, Sugarloaf and Outer Islands. Counts of adult females and juveniles in each region in 2004 were also available from the medium format aerial survey (NMFS unpublished data). An estimate of the proportion of all CGOA females that were observed was made by assuming a 50:50 sex ratio for counted juveniles, adding half the juvenile count to the adult female count, and dividing by the number of 1+ females estimated by the model. Comparisons of the estimated and counted adult and all females in the central Gulf of Alaska (below) indicate that 44-45% of all females in the population are counted in the survey, which agrees well with other estimates of sea lion summer sightability (see Holmes et al. 2007).

Rates of "successful natality" are defined here as the total number of live pups estimated in late-June/early July divided by the total number of mature females in the region. "Successful natality" is a product of the late-term pregnancy rate of adult females, rates of late-term abortion/stillbirth, and early (first month of age) neonate mortality. In 2005, a medium-format survey of pup production was conducted of all rookeries and major haul-outs on which greater than 10 pups had been observed in previous surveys. Applying the 2004 adult female observation rate (44%) to the 2005 adult female count on rookeries in each sub-area yielded estimates of the total number of adult females on rookeries in each sub-area (Table 2). Dividing sub-area pup counts on rookeries by the estimated adult female population on rookeries yielded an estimate of 'successful natality' (birth rate plus 1-month pup survival) for adult females on rookeries. For the entire western stock in Alaska, rates of 'successful natality' averaged 36% on rookeries, but ranged as low as 26% in the western Aleutians to as high as 39% for the central Aleutians. The four sub-areas in the Kenai-Kiska area had rates of 'successful natality' ranging from 35-39%, but the central Gulf was at the lower end of this range.

To estimate 'successful natality' of all adult females in each sub-area, it is necessary to estimate the total number of pups born as well as the total number of adult females in each sub-area. While most adult females were counted on rookeries in 2004, a significant proportion of adult females (22%) were on haul-outs. Applying the adult female observation rate (44%) to the sub-area counts of adult females on haul-outs in 2004, the total number of adult females on haul-outs in each sub-area was estimated and summed to get the total for the western stock in Alaska (Table 3). Also from the 200 survey, 95% of all pups were counted on rookeries, while only 5% were counted on haul-outs. In 2005, there were a total of 9,616 pups counted on rookeries in the western stock, which yields an estimated total pup production of 10,090, with an estimated 474 born on haul-outs (based on the 2004 ratios). Dividing the estimated number of pups born on haul-outs in 2005 by the estimated number of adult females using haul-outs (in 2004) yields an estimated 'successful natality' rate of only 6%; this is less then 1/5 of the rate of adult females on rookeries. For all adult females in the western stock in Alaska in 2005 (estimated N = 34,221), the average rate of 'successful natality' (estimated N = 10,090 pups) was 29%, but ranged from a low of 26% at the edges of the range in the eastern Gulf and western Aleutians, to a high of 32% in the central Aleutians. Rates of 'successful natality' were highest from the Kenai Peninsula to Kiska Island, but within this area, were lowest in the central Gulf (29%).

Holmes *et al.* (2007) estimated that the rate of 'successful natality' declined 34% from 1976 to the period 1998-2004, which yields an estimate of 'successful natality' in 1976 of 44%. This is the baseline rate of 'successful natality' and is the assumed rate for the entire western DPS in Alaska for 1976. Based on this assumption, an estimate of the proportion of the 1976 rate that females in each region are currently experiencing was calculated (Table 3). The regional pattern of changes in rates of 'successful natality' suggests that rates have declined the most at the edges of the range, in the eastern Gulf and western Aleutians (currently only 52-53% of 1976 rates), and less in the Kenai-Kiska area (66-74% of 1976 rates). This also suggests that within the core of the range, rates of 'successful natality' declined more in the central and western Gulf than in the eastern and central Aleutians.

3.1.16.5 Population Projections

In the Alaskan western DPS, index counts of non-pups increased at about 3% per year between 2000 and 2004 (Fritz and Stinchcomb 2005) and then appears to have stabilized from 2004 to 2007 except in the WAI (Fritz *et al.* 2008). In the CGOA, however, non-pup counts declined slightly from 2000 to 2004 but at a slower rate than in the 1990s. The results of Holmes *et al.* (2007) suggest (a) that natality has continued to decline in the CGOA, and (b) the slowing of the decline in non-pup numbers observed since 2000 is due to increases in survivorship of juvenile and adult Steller sea lions. Therefore, in order to achieve the 3% per year increases observed between 2000 and 2004 in the western DPS one or more vital rates had to be greater in other regions than in the central GOA.

Little is known about regional changes in survivorship, but regional ratios of pups to adult females on rookeries (adjusted for observability) from the 2004-2005 aerial surveys revealed a regional trend in natality rates: natality was highest in the central Aleutians (39%) and declined slightly to the east (38% in the EAI, 36% WGOA, and 35% CGOA); natality rates were lower outside the Kenai-Kiska area (26% in the WAI and 29% in the EGOA).

The size of the Alaskan western DPS female Steller sea lion population was projected through 2015 by making assumptions about changes in juvenile and adult survivorship and rates of successful natality. The year 2015 was chosen because it represents the end of a 15-year period of increase (beginning in 2000) when the population's status relative to the down-listing criteria in the Recovery Plan (NMFS 2008) will be assessed. A current (2004/5) estimate of the female population of Steller sea lions in the western DPS was made by NMFS (2006a; Table 3.25). This was based on the Holmes *et al.* (2007) estimate of the numbers of females at age in the central Gulf of Alaska in 2004, a life table for the CGOA population (age-specific rates of survivorship and natality; Table 3.28) for the mid-1970s, and data from the 2004-2005 medium format aerial surveys of the Alaskan western DPS. To make projections for the entire western DPS through 2015;

- the 2004 age-structure of the female population in the central GOA was applied to each of the six sub-areas of the Alaskan portion of the western DPS (Table 3.25),
- region-specific rates of natality were calculated based on both the changes from the mid-1970s estimated for the central GOA (Holmes and York 2003; Holmes et al. 2007) and the ratio of pups to adult females in each sub-region from medium-format aerial surveys conducted in 2004 and 2005 (Table 3.26 and 3.28),
- region-specific natality rates were multiplied by a scalar to yield rates across the western DPS that were +10%, 0%, -10%, -20%, -30%, -33%, and -40% of those estimated for the mid-1970s (-33% was similar to the rate estimated for the central Gulf), and
- adult survivorship across the wDPS was fixed at integer rates (2-7%) greater than mid-1970s rates for all ages 4-31 (trend observed in Holmes and York (2003), Fay and Punt (2006), and Holmes *et al.* (2007);

- thus, for all combinations of changes in rates of successful natality and adult survivorship, the change in the rate of juvenile survivorship necessary to achieve western population growth rates of 0%, 1%, 2%, and 3% per year was calculated.

Population projections were made with the following constraints on changes in vital rates:

- No single rate of juvenile survival could be greater than 95%
- No single rate of adult survival could be greater than 98%
- No single rate of natality (female pups per female per year) could be greater than 0.48

The best available information from brand-resight analyses and modeling exercises indicates that juvenile survivorship in the CGOA is currently (since 2000) about 95% of rates observed in the late 1970s (though it has increased substantially since the early 1980s) (NMFS 2006b, Holmes et al. 2007). If this is true for the rest of the western DPS and if the western DPS is to have a sustained (through 2015) population growth rate of at least 1%, then:

- adult survivorship must be considerably greater than in the 1970s (as much as 7% greater), and
- declines in natality must only be modest (ca. -10%).

This is largely because there is only limited improvement possible between the mid-1970s rates of adult survivorship (maximum at age 4 of 91%) and a realistic cap of 98%. The 2000-2004 population increase was achieved largely through an increase in survivorship and in spite of a decline in natality. We would expect that if these survival rates remain high, there would be only a temporary population increase due to the unstable age structure created. It appears that we may have seen this with the stable trend in non-pup trend site counts from 2004 to 2007 (Fritz *et al.* 2008). Further improvements in adult survivorship may be technically possible but are unlikely to improve substantially due to the fact that they already approach the maximum for many ages. Management actions taken in the 1990s to reduce direct mortality of sea lions (e.g., prohibition on shooting, substantially reduced incidental take, declining subsistence harvest) are likely at least partially responsible for the increase in survivorship. Measures to reduce competitive overlap for prey may also be responsible (see Hennen 2005). Given the similarity of trend site counts from the 2004, 2006 and 2007 non-pup surveys, the results of vital rate analyses, and the current age structure of the population (increasing average age), it appears unlikely that the western DPS of Steller sea lion will achieve the recovery plan's down- or delisting standards without increases in birth rates.

3.2 Steller Sea Lion Designated Critical Habitat

The term "critical habitat" is defined in the ESA (16 U.S.C. 1532(5)(A) to mean:

> *(i) the specific areas within the geographic area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of this Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management consideration or protection; and (ii) the specific areas outside of the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of this Act, upon a determination by the Secretary that such areas are essential to the conservation of the species.*

On August 27, 1993 NMFS published a final rule to designate critical habitat for the Steller sea lion (58 FR 45269). The areas designated as critical habitat for the Steller sea lion were determined using the best information available at the time (see regulations at 50 CFR part 226.202; Table 2.39 and 2.40), including information on land use patterns, the extent of foraging trips, and the availability of prey items. Particular attention was paid to life history patterns and the areas where animals haul out to rest, pup, nurse their pups, mate, and molt. Critical habitat areas were finally determined based upon input from NMFS scientists and managers, the first Steller Sea Lion Recovery Team, independent marine mammal scientists invited to participate in the discussion, and the public.

3.2.1 Description of Critical Habitat for Steller Sea Lions

Steller sea lions require both terrestrial and aquatic resources for survival in the wild. Land sites used by Steller sea lions are referred to as rookeries and haulouts. Rookeries are used by adult males and females for pupping, nursing, and mating during the reproductive season (late May to early July). Haulouts are used by all size and sex classes but are generally not sites of reproductive activity. The continued use of particular sites may be due to site fidelity, or the tendency of sea lions to return repeatedly to the same site, often the site of their birth. Presumably, these sites were chosen by sea lions because of their substrate and terrain, the protection they offer from terrestrial and marine predators, protection from severe climate or sea surface conditions, and the availability of prey resources.

Steller sea lion critical habitat is listed in 50 CFR §226.202 (all major Steller sea lion rookeries are identified in Table 1 and major haulouts in Table 2 along with associated terrestrial, air, and aquatic zones). NMFS recognizes that more accurate locations for the sites listed in 50 CFR §226.202 are available. Advances in technology and repeated surveys to these areas have resulted in more precise and accurate location estimates. NMFS intends to update these locations as soon as practicable. However, the current inaccuracy in some of the locations in 50 CFR §226.202 does not substantially diminish the utility of those designations, rather, more accurate locations would aid those citizens attempting to navigate or fish near these listed sites.

Two kinds of marine foraging habitat were designated as critical: (1) areas immediately around rookeries and haulouts, and (2) three aquatic foraging areas where large concentrations of important prey species were known to occur.

First, areas around rookeries and haulout sites were chosen based on evidence that many foraging trips by lactating adult females in summer may be relatively short (20 km or less; Merrick and Loughlin 1997). Also, mean distances for young-of-the-year in winter may be relatively short (about 30 km; Merrick and Loughlin 1997, Loughlin *et al.* 2003). These young animals are just learning to feed on their own, and the availability of prey in the vicinity of rookeries and haulout sites must be crucial to their transition to independent feeding after weaning. Similarly, haulouts around rookeries are important for juveniles, because most juveniles are found at haulouts not rookeries. Evidence indicates that decreased juvenile survival may be an important proximate cause of the sea lion decline (York 1994, Chumbley *et al.* 1997) and that the growth rate of individual young sea lions was depressed in the 1980s (Calkins and Goodwin 1988). These findings are consistent with the hypothesis that young animals were nutritionally stressed. Furthermore, young animals are almost certainly less efficient foragers and may have relatively greater food requirements, which, again, suggests that they may be more easily limited or affected by reduced prey resources or greater energetic requirements associated with foraging at distant locations. Therefore, the areas around rookeries and haulout sites must contain essential prey resources for at least lactating adult females, young-of-the-year, and juveniles, and those areas were deemed essential to protect.

Second, three marine areas were chosen based on 1) at-sea observations indicating that sea lions commonly used these areas for foraging, 2) records of animals killed incidentally in fisheries in the 1980s, 3) knowledge of sea lion prey and their life histories and distributions, and 4) foraging studies. In 1980, Shelikof Strait was identified as a site of extensive spawning aggregations of pollock in winter months. Records of incidental take of sea lions in the pollock fishery in this region provide evidence that Shelikof Strait is an important foraging site (Loughlin and Nelson 1986, Perez and Loughlin 1991). The southeastern Bering Sea north of the Aleutian Islands from Unimak Island past Bogoslof Island to the Islands of Four Mountains is also considered a site that has historically supported a large aggregation of spawning pollock, and is also an area where sighting information and incidental take records support the notion that this is an important foraging area for sea lions (Fiscus and Baines 1966, Kajimura and Loughlin 1988). Finally, large aggregations of Atka mackerel are found in the area around Seguam Pass. These aggregations have supported a fishery since the 1970s and are in close proximity to a major sea lion rookery on Seguam Island and a smaller rookery on Agligadak Island. Atka mackerel are an important prey of sea lions in the central and western Aleutian Islands. Records of incidental take in fisheries also indicate that the Seguam area is important for sea lion foraging (Perez and Loughlin 1991).

Designated critical habitat for Steller sea lions (both eastern and western DPSs) includes:

- A terrestrial zone that extends 3,000 feet (0.9 km) landward from the baseline or base point of each major rookery and major haulout
- An air zone that extends 3,000 feet (0.9 km) above the terrestrial zone, measured vertically from sea level
- An aquatic zone that extends 3,000 feet (0.9 km) seaward in State and Federally managed waters from the baseline or basepoint of each major haulout in Alaska that is **east** of 144° W long.

- An aquatic zone that extends 20 nm (37 km) seaward in State and Federally managed waters from the baseline or basepoint of each major rookery and major haulout in Alaska that is west of 144° W long.
- Three special aquatic foraging areas in Alaska; the Shelikof Strait area, the Bogoslof area, and the Seguam Pass area described below:

Shelikof Strait Foraging Area

Critical habitat includes the Shelikof Strait area in the Gulf of Alaska which consists of the area between the Alaska Peninsula and Tugidak, Sitkinak, Aiaktilik, Kodiak, Raspberry, Afognak and Shuyak Islands (connected by the shortest lines): bounded on the west by a line connecting Cape Kumlik (56°38'N/157°26'W) and the southwestern tip of Tugidak Island (56°24'N/154°41'W) and bounded in the east by a line connecting Cape Douglas (58°51'N/153°15'W) and the northernmost tip of Shuyak Island (58°37'N/152°22'W).

Bogoslof Foraging Area

Critical habitat includes the Bogoslof area in the Bering Sea shelf which consists of the area between 170°00'W and 164°00'W, south of straight lines connecting 55°00'N/170°00'W and 55°00'N/168°00'W; 55°30'N/168°00'W and 55°30'N/166°00'W; 56°00'N/166°00'W and 56°00'N/164°00'W and north of the Aleutian Islands and straight lines between the islands connecting the following coordinates in the order listed:

52°49.2'N/169°40.4'W; 52°49.8'N/169°06.3'W; 53°23.8'N/167°50.1'W; 53°18.7'N/167°51.4'W; 53°59.0'N/166°17.2'W; 54°02.9'N/163°03.0'W; 54°07.7'N/165°40.6'W; 54°08.9'N/165°38.8'W; 54°11.9'N/165°23.3'W; 54°23.9'N/164°44.0'W

Seguam Pass Foraging Area

Critical habitat includes the Seguam Pass area which consists of the area between 52°00'N and 53°00'N and between 173°30'W and 172°30'W.

3.2.2 Essential Features of Critical Habitat

The regulations at 50 CFR §424.12(b) outline those physical and biological features which should be considered when designating critical habitat for listed species:

1. Space for individual and population growth, and for normal behavior;
2. Food, water, air, light, minerals, or other nutritional or physiological requirements;
3. Cover or shelter;
4. Sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and generally;
5. Habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

In general, the physical and biological features of critical habitat essential to the conservation of Steller sea lions are those items that support successful foraging, rest, refuge, and reproduction. The August 27, 1993 final rule to designate critical habitat for the Steller sea lion (58 FR 45269) describes essential aquatic (foraging areas) and terrestrial features (rookeries and haulouts) of critical habitat and the rational behind the regulatory definition of critical habitat.

3.2.2.1 Essential Features of Marine Critical Habitat

Prey resources are the most important feature of marine critical habitat for Steller sea lions (see 58 FR 45269). Marine areas may be used for a variety of other reasons (e.g., social interaction, rafting or resting), but foraging is the most important sea lion activity that occurs when the animals are at sea. A discussion of sea lion foraging patterns and prey use is discussed in Sections 3.1.7 and 3.1.8. While many of the important physical and biological elements of Steller sea lion critical habitat can be identified, most of those features (particularly biological features) cannot be described in a complete and quantitative manner. In the listing notice, sea lion prey was described as one of the primary essential features of critical habitat within foraging areas. Walleye pollock, Atka mackerel, Pacific cod, rockfish, herring, capelin, sand lance, other forage fish, squid, and octopus are important prey items found in Steller sea lion critical habitat. Due to the dynamic nature of aquatic ecosystems and fish, NMFS was unable to describe the specific attributes of prey within critical habitat. Thus, the prey (fish) resources are described in general and constantly re-assessed to determine their conservation value to Steller sea lions. The status of critical habitat is best described as the status of the important prey resources contained within those areas. These fishery resources are evaluated annually and that description is contained in the stock assessment and fishery evaluation (SAFE) reports.

3.2.2.2 Essential Features of Terrestrial Critical Habitat

In this section we describe important Steller sea lion habitat areas based on usage patterns. This includes the determination of important sites not previously designated as critical habitat under the ESA, a review of rookeries, and a description of the seasonal usage of both ESA and non-ESA designated sites.

Long-used rookery sites were likely selected by sea lions for a variety of reasons, including substrate and terrain, protection from land-based and marine predators, protection from harsh wave or surf conditions, and local availability of prey. Successful reproduction for the species depends on the availability of rookery sites where animals can aggregate for sufficiently long periods of time to give birth, mate, and raise their young until the young are able to survive at sea. As the reproductive period requires at least several months, food supplies in the vicinity of the rookeries must be sufficient to meet the energetic needs of animals involved in reproduction (adult females and males and pups). Once the reproductive season and the need for social aggregation is over, and pups have gained sufficient competence at sea, then animals (including mothers with pups) may not disperse to other haulout sites. Throughout the remainder of the year, the local availability of prey remains a crucial factor (probably the most important factor) in determining their movements and distribution. Mothers with dependent pups are still likely to be constrained in their foraging distribution. All pups are susceptible because they have limited reserves compared to adult animals. Pups in the process of weaning are likely poor foragers that may be susceptible to reductions in prey availability. Pups are likely dependent on nearshore prey resources while they make the difficult transition to independent foraging. Juveniles, older but still immature, must continue to develop their foraging skills over time, but probably remain particularly sensitive to reductions in available prey. Like other, older animals, they may range more widely, but their distribution and haulout patterns must be determined, in large part, by the availability of prey.

The foraging success of these animals, whether based on rookeries or haulouts, is determined by their ability to balance the gains from foraging with the costs of daily activities, including the act of foraging itself (i.e., energy balance). If the prey resources around rookeries and haulouts are inadequate for their needs (potentially reduced or depleted), then they are forced to increase the time and energy expended to find sufficient prey. As a result, they are more likely to fail in securing the resources necessary for growth, reproduction, and survival. Population recovery will likely depend upon increased reproduction and juvenile survival.

Determination of Important Terrestrial Sites not Designated as Critical Habitat

In a 1998 biological opinion (NMFS 1998), NMFS identified nineteen Steller sea lion sites which were not designated as critical habitat but which required special management measures in order to avoid jeopardizing the western DPS. The determination was based on historical population counts in which at least one recorded count of non-pup Steller sea lions exceeding certain criteria during the breeding (greater than 200 non-pups from May-August) or non-breeding seasons (greater than 75 non-pups from September-April; Table 2.26). The database queried for the 1998 analysis was the Alaska Adult Count database maintained by NMML and available on the NMML website. The original 19 sites were not designated as critical habitat, but were included for management purposes as part of the Revised Final Reasonable and Prudent Alternative (RFRPA) process (NMFS 1999).

The analysis was repeated again in March 2006 (NMFS 2006b) and updated through breeding season non-pup surveys conducted in 2006 and 2007 (Fritz et al. 2008). The criteria for breeding season haulout use remained the same (>200 non-pups), but the non-breeding season threshold count was raised from 75 to 100 non-pups. This was based on the work of Sease and York (2003), who found that non-breeding season counts were approximately half those of breeding season counts. The threshold number of 200 was used previously during critical habitat designation to determine which haul-outs were "major" based largely on counts conducted during the breeding season. Therefore, the 200 non-pup breeding season count was retained as the threshold, and the non-breeding season count of 100 was used to identify major non-breeding season haulouts.

Analysis of non-pup count data collected through 2007 indicates that Samalga Island and Amchitka/Cape Ivakin could be removed from the list of 19 important sites because:

- Samalga had only 1 breeding season count > 200 (490 in 1985, but no more than 10 in any single survey since 1989).

- Amchitka/Cape Ivakin had only 1 one breeding season count > 200 (450 in 1959, and no more than 2 in any single survey since 1989).

Ugamak/Round failed to meet either criteria since 1990, but should be retained as an important site for management purposes. It is an integral part of the Ugamak Island rookery complex (Ugamak/Ugamak Bay and Ugamak/North) and represents a significant terrestrial site within that complex.

An additional 21 haul-out sites were identified as meeting the criteria for an important site. However, only six sites met the criteria since 1990 and should be included as important sites:

- ELIZABETH/CAPE ELIZABETH had 112 non-pups in March 1993
- FLAT had 174 non-pups in Dec 1994 and 125 in March 1999
- UNGA/ACHEREDIN POINT had 264 non-pups in June 2004
- UNIMAK/OKSENOF POINT had 269 non-pups in June 2007
- TAGALAK had 150 non-pups in March 1999
- SEMISOPOCHNOI/TUMAN POINT had 154 non-pups in March 1993

The remaining fifteen sites technically met the criteria, but all had only 1 or 2 counts that met the criteria and all but two occurred prior to 1966. Therefore, the following sites may not be currently important sites:

- USHAGAT/ROCKS SOUTH (breeding 1985)
- UGAIUSHAK (breeding 1956)
- AKUN/AKUN HEAD (non-breeding 1960)
- AKUTAN/NORTH HEAD (non-breeding 1957)
- EGG (non-breeding 1957)
- UNALASKA/CAPE STARICHKOF (non-breeding 1960 and breeding 1977)
- UNALASKA/SPRAY CAPE (non-breeding 1960)
- CARLISLE (breeding 1960 and breeding 1965)
- AMLIA/CAPE MISTY (breeding 1959)
- IKIGINAK (breeding 1959)
- IGITKIN/SW POINT (breeding 1959)
- SKAGUL/S. POINT (breeding 1959)
- GARELOI (breeding 1960).
- USHAGAT is the island on which USHAGAT/SW is located, and the latter is both an ESA-listed haul-out and an RFRPA site
- AMATIGNAK is the island on which AMATIGNAK/NITROF POINT is located, and the latter is both an ESA-listed haul-out and an RFRPA site.

Determination of Important Rookeries

Rookeries are terrestrial locations where sea lions breed and give birth. While this may occur to some extent on a large number of sites, a site has previously been designated as a "rookery" when a minimum number of pups have been born and certain demographic and behavioral characteristics have been observed including: bulls defending territories occupied by adult females with pups, a low proportion of juvenile animals, and sub-adult males occupy the area outside of defended territories. It is important to identify these rookery sites such that appropriate management can be applied to rookeries which are more vulnerable to stressors during the summer pupping and breeding season.

For this analysis, rookeries were defined as sites with a pup count of at least 50 since 1978. In support of this value, the age and sex composition of the sea lion population occupying these rookeries was compared with that on haulouts based on analysis of medium format photographs taken in 2004 (NMFS 2006b). Based on the analysis (NMFS 2006b), five new sites[9] should be considered rookeries, for conservation purposes, based on the following evidence (NMFS 2006b):

- Chiswell Islands: N = 58 pups in 2000
- Jude Island: N > 50 pups in 2002-2005
- Kanaga/Ship Rock: N > 50 pups in 2004-2005
- Lighthouse Rocks: N > 50 pups in 1978 (N=250) and 1979 (N=112)
- Ushagat/SW: N = 55 pups in 2005

Four sites previously designated as rookeries should be considered as haulouts because none have had a pup count >50 (NMFS 2006b; Agligadak, Semisopochnoi/Pochnoi, Semisopochnoi/Petrel, Amchitka/East Cape). The remaining 34 ESA-listed rookeries should retain their rookery status, and the five sites listed above should be added to this list for a total of 39 rookeries:

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[9] These 5 sites are designated critical habitat haulouts under the ESA (50 CRR part 226.202). Although the designation includes a determination of haulout or rookery for each site, no specific action is required in the ESA designation. However, the type of site is important when considering whether the habitat is being conserved under Section 7 of the ESA. Therefore, accurate description of whether a site is a haulout or rookery is important and must be updated occasionally as usage patterns change due to population demographics and environmental changes.

Area	Rookeries
Western Aleutians (N = 4)	ATTU/CAPE WRANGELL, AGATTU/CAPE SABAK, AGATTU/GILLON POINT, and BULDIR
Central Aleutians (new N = 12)	KISKA/CAPE ST STEPHEN, KISKA/LIEF COVE, AYUGADAK, AMCHITKA/COLUMN ROCK, ULAK/HASGOX POINT, TAG, GRAMP ROCK, ADAK/LAKE POINT, KASATOCHI/NORTH POINT, SEGUAM/SADDLERIDGE, and YUNASKA [**add KANAGA/SHIP ROCK; subtract Agligadak, Semisopochnoi/Pochnoi, Semisopochnoi/Petrel, and Amchitka/East**]
Eastern Aleutians (N = 7)	ADUGAK, OGCHUL, BOGOSLOF/FIRE ISLAND, AKUTAN/CAPE MORGAN, AKUN/BILLINGS HEAD, UGAMAK COMPLEX, and SEA LION ROCK (AMAK)
Bering Sea (N = 1)	WALRUS
Western Gulf (new N = 6)	CLUBBING ROCKS, PINNACLE ROCK, CHERNABURA, and ATKINS [**add JUDE and LIGHTHOUSE ROCKS**]
Central Gulf (new N = 6)	CHOWIET, CHIRIKOF, MARMOT, SUGARLOAF, and OUTER (PYE) [**add USHAGAT/SW**]
Eastern Gulf (new N = 3)	WOODED (FISH) and SEAL ROCKS [**add CHISWELL ISLANDS**]

Determination of Terrestrial Seasonal Usage Patterns

The selection of important sites and seasons is based on the requirement to provide the protection necessary for recovery and conservation of the species. The analysis evaluates important sites and seasons based on seasonal counts from 1990-2005. NMFS used a count of 200 non-pups as the threshold for determining whether a site was important during the summer (May – October) and a count of 100 as the threshold for November - April. Two thresholds were used because haulout use patterns change between these periods. The 200 non-pup threshold had previously been used by Steller Sea Lion Recovery Team as a criterion for identifying major sites to be included in the critical habitat designation. Their concern was related, in part, to a judgement that to remain viable, a subpopulation of animals at a particular site should contain 50 or more adult females, which was not likely unless the entire subpopulation consisted of at least 200 animals. The threshold for the winter period was lowered to 100 animals for the following reasons. First, Sease and York (2003) evaluated winter sea lion counts and found that roughly half the numbers of sea lions were observed during the winter surveys. Second, sea lions disperse more widely in winter to find sufficient prey and, on average, aggregations are likely to be smaller. Third, they may be required to spend more time at sea and less time at haulouts where they would be counted. And fourth, only three counts have been conducted during this period, and those counts were conducted in recent years (1993, 1994, and 1999). The counts are the best available data for assessing the potential importance of haulout sites. Nevertheless, the counts are also limited (especially the winter counts), and may underestimate the value of haulout sites to sea lions. The list includes all of the sites designated as critical habitat as well as the additional 23 sites identified above.

The list includes 34 sites which did not meet either seasonal criteria during this time period, and reflects the changes described above to which sites are currently functioning as important rookeries.

- Surveys were not conducted every year. Summer surveys were conducted in 1990, 1991, 1992, 1994, 1996, 1998, 2000, 2002, and 2004. Partial intermittent surveys were conducted in 1981-1984 and 1986-1988. As noted above, winter surveys were conducted only in 1993, 1994, and 1999. In general, surveys were less common during the 1980s (when the population was larger) than in the 1990s (after the steepest part of the decline). Therefore, these data would be more likely to miss historically important sites.

- In almost every year in which a survey was conducted, only a single count was made. That count represents a snapshot of a haulout at a particular time. If the count occurred at an important site when few animals were ashore (due to weather or other factors), then the value of the haulout would not have been reflected in the count. For example, the summer counts at Cape Barnabas have revealed zero or one sea lion on the site since 1989. However, incidental counts at Cape Barnabas in December 1993 and March 1994 revealed 124 and 31 animals, suggesting considerable variation in the use of sites within the year (and indicating that this is still an important site to sea lions). Such within-year variation is not measured when counts are conducted once a year.

Therefore, while these are the best available data for the purpose of identifying important haulout sites, the breeding and non-breeding seasonal counts summarized here could under-represent the importance of some haulout sites to sea lions and, on that basis, should not be considered conservative.

Even haulout sites where few or even no animals have been counted in recent years may require some protection in order to promote recovery. This is based on the general importance of habitat conservation to the recovery of protected species. Recovery can not occur if the habitat essential to support a recovering or recovered population is not available. That is, the essential habitat must be available before recovery can occur. The importance of habitat protection is underscored by the requirements of the ESA. The ESA recognizes the crucial link between habitat and recovery, and therefore requires that every federal agency not only avoid jeopardy to such species, but also avoid "destruction or adverse modification of critical habitat." The notion of delaying protection of habitat until after a species has recovered is therefore inconsistent with our understanding of the link between a species and its habitat, with our understanding of the recovery process, and with the requirements of the ESA.

Finally, factors other than the decline could have altered the distribution patterns of Steller sea lions and the relative importance of their haulouts. However, the best available scientific and commercial data are not sufficient to describe such a change in haulout patterns as a result of changes in oceanographic parameters or changes in composition of the prey community. As described above, the existing data on haulout patterns is sufficient to indicate some hauling sites that have been or are currently important to sea lions. It is not sufficient to detect shifting patterns of use that could be attributed to any general factor.

Summary Of Standards Used To Determine Important Sites

The following general standards were used to make determinations about important sites (described above):

Summer haulout: > 200 non-pups in at least 1 year since 1990
Winter haulout: > 100 non-pups in at least 1 year since 1990
Summer rookery: > 50 pups in at least 1 year since 1975 (and had > 200 non-pups since 1990)
Winter rookery: > 100 non-pups in at least 1 year since 1990 (site must also be classified as summer rookery)

4. BASELINE

The Environmental Baseline is an analysis of the effects of past and ongoing human-caused and natural factors leading to the current status of the species or its habitat and ecosystem within the action area. Environmental baselines for biological opinions include past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

The Environmental Baseline represents the impacts of a suite of prior and contemporaneous human activities, and natural phenomena, on threatened and endangered species and on designated critical habitat. Environmental Baselines are not "lines" defined in time, but are base conditions for the individuals, populations, and constituent elements (within critical habitat) that occur within an action area. The purpose of an Environmental Baseline is to describe the response of listed resources that have been exposed to physical, chemical, biotic, and ecological stressors (and subsidies) directly or indirectly caused by the suite of activities. This suite of activities represents subsidies (for example, additional opportunities for sea lions to eat by catching fish caught in nets) and stressors (for example, being shot or harassed by fishermen, having less food available in the water column, having to spend more time searching for food, experiencing disturbance on rookeries and haulouts from overflights, etc.). The set of subsidies and stressors associated with the activities form a response regime. These response regimes might change from place to place (for example, you might have one response regime in the western Aleutians and another in the Central Gulf of Alaska) and over time.

When we develop the Environmental Baseline (this chapter), we assess the base condition of the listed individuals and the populations those individuals comprise. We assess the base condition of designated critical habitat.

4.1 Ecosystem Dynamics in the Action Area

In the North Pacific Ocean, Steller sea lions inhabit a diverse and complex ecosystem, which they share with many other species. Detailed descriptions of physical and biological characteristics of the Gulf of Alaska and Bering Sea have been compiled by Hood and Calder (1981), Hood and Zimmerman (1986), National Research Council (1996), Trites *et al.* (1999, 2006a), Loughlin and Ohtani (1999), and Guenette and Christensen (2005).

Physical aspects of the environment obviously determine whether or not an area is suitable for sustaining Steller sea lions, or any other life form. Physical parameters that may be important to sea lions include coastal geomorphology, air and water temperatures, wind speeds, wave conditions, tides, currents, etc. A few recent studies have addressed how such factors may influence sea lion distribution and abundance. One showed that the terrestrial sites used by Steller sea lions tend to be associated with waters that are relatively shallow and well-mixed, with average tidal speeds and less-steep bottom slopes (Ban 2005). Another study identified patterns in ocean climate that are consistent with the patterns of sea lion distributions, population trends, numbers and diets (Trites *et al.* 2006a). Thus, there appears to be a linkage between Steller sea lions and the physical environment, which likely plays a major role in determining the northern and southern limits of the Steller sea lion range.

Physical characteristics of the ecosystems inhabited by sea lions are not static, but rather show variations on several time scales (Schumacher and Alexander 1999, Trites *et al.* 2006a). Considerable attention has recently been given to abrupt decadal scale changes in long term data series that describe the climate, oceanic conditions and abundances of a number of species in the North Pacific. The largest such change recorded this past century occurred in the mid-1970s (Ebbesmeyer *et al.* 1991, Graham 1994, Francis *et al.* 1998). In some cases fluctuations in fish, bird, and mammal populations seem to correlate with these decadal scale climate changes (Springer 1998, 2004, Benson and Trites 2002, Polovina 2005, Trites *et al.* 2006a). Food web interactions (Trites 2003), predation (Barrett-Lennard *et al.* 1995) and disease (Burek *et al.* 2003, Goldstein 2004) are all biotic components of the ecosystem that are important to Steller sea lions as they function as food, competitors, predators, parasites, and disease agents.

Human exploitation of marine mammals and fishes in the North Pacific Ocean over the past 250 years has undoubtedly modified the environment that Steller sea lions occupy (NRC 2006). The precise effects on Steller sea lions of all factors have been impossible to determine, but have likely been substantial, variable over time, and both top-down and bottom-up in nature. This human modification of marine mammals and fish stocks has occurred against a complicated pattern of climate and oceanographic variability, both natural and human-catalyzed as well as human use of coastal waters and nearby lands that has increased the potential for disturbance and pollution. The history of the Steller sea lion, their prey, and the ways in which both natural and anthropogenic forces have affected both is extremely complex.

Ecosystem models are available for the Aleutian Islands, Eastern Bering Sea and Southeast Alaska. These models can be used to gain insight into the combined effects that fishing, predation, ocean climate change, and interspecies interactions have had on Steller sea lions and their ecosystems as a whole (e.g., Trites *et al.* 1999, Guenette and Christensen 2005). These models indicate that bottom-up and top-down processes occur simultaneously and suggest that Steller sea lions have been both positively and negatively affected by changes in their food base (due to fishing and ocean climate change), as well as by competition with large flatfish, and that they are potentially affected by predation by killer whales (particularly when sea lion numbers are low). Further work is continuing with these models to assist in better understanding the complex ecosystem interactions underway in the North Pacific.

4.1.1 Environmental Variability

On a large spatial and temporal scale, the major mode of physical variability in the North Pacific has been identified as the Pacific Decadal Oscillation (PDO), which was described in the 1990s (Francis and Hare 1994, Mantua *et al.* 1997), but as of late 2003 may no longer be considered oscillatory (Bond *et al.* 2003).This may be a coupled ocean atmosphere phenomenon (some argue that it's a true coupled system oscillation like ENSO (Latif and Barnett 1996), but the physical mechanisms are largely undescribed) which results in sea surface temperature (SST) and sea level pressure (SLP) anomalies and altered circulation in the entire North Pacific ocean. Clear "regime shifts" with fundamentally different SST and SLP patterns in space manifested in the atmosphere ocean system do appear on a decadal scale, in particular in 1946-47 and in 1976-77. The U.S. west coast, eastern tropical Pacific, and the Gulf of Alaska shelf were warmer and the Central North Pacific was cooler post 1977 compared with the decades before (Zhang *et al.* 1997). An additional regime shift has been identified in 1925 (Mantua *et al.* 1997). The decadal variability in the mid latitudes may be related to and definitely interacts with the better understood tropical atmosphere ocean variability that results in the El Nino Southern Oscillation (ENSO), which has an inter-annual timescale. However, it has been pointed out that there have been other reversals in the patterns of SST and SLP which are just as dramatic from a physical standpoint as those in the early 1940s and late 1970s, but which did not persist as long and therefore have not been termed regime shifts in retrospect (e.g. 1957-58, Zhang *et al.* 1997). "Regime shift" may therefore be interpreted as not a purely physically defined phenomenon, but one which requires an associated biological shift to be described in order to receive official recognition. Therefore, it is important to look at the type and spatial scale of physical forcing, as well as its persistence with respect to biological communities, because it seems feasible that species with certain life histories would respond to any multi-year shift in physical conditions while others would require at least decadal variability to respond, and the interaction between these species throughout the responses would also contribute to ecosystem dynamics.

Localized physical characteristics of the Gulf of Alaska continental shelf ecosystem are important to understanding the spatial and temporal variability in the biological communities as well, especially since many of its environmental parameters do not appear to display any decadal signal over the past 50 years (Stabeno *et al.* 2004). Perhaps the two most important broad circulation features in the coastal Gulf of Alaska are the Alaska Stream and the Alaska Coastal Current (Reed and Schumacher 1987). The Alaska Stream runs relatively narrow and fast along the shelf break from the Northern GOA off Cape St. Elias towards the Aleutian Islands in the west. The position and strength of this current and its interaction with bottom topography is thought to alter the nutrient supply to phytoplankton on the shelf, along with seasonal wind driven cross shelf (Ekman) transport and entrainment due to freshwater runoff (Parsons 1987, Sambrotto and Lorenzen, 1987). Recent information indicates that the Alaska Stream is relatively steady within a season, but exhibits variability on interannual timescales (Hermann *et al.* 2002). The Alaska Coastal Current is a weaker flow in general; running parallel to the Alaska Stream closer to shore and through Shelikof Strait, but it is seasonally quite variable due to changes in freshwater runoff, which usually peaks in September-October (Stabeno *et al.* 2004). Runoff also changes surface salinity and therefore water column stratification on the GOA shelf seasonally and locally, contributing to spatial and temporal variation in productivity. Vertical flow of water from surface to bottom (downwelling) and deep waters to surface (upwelling) can maintain or disrupt the flow of nutrients to the better lit surface waters where marine plants (phytoplankton) reside—therefore, downwelling and upwelling are important processes for biological production (Valiela 1995, Mann and Lazier

1991). Both seasonal downwelling and upwelling occur locally on the GOA continental shelf as a result of the interactions of these currents, runoff, and seasonally as well as locally varying winds (Stabeno *et al.* 2004). In general, downwelling dominates the system during the winter seasons, and (sporadic) upwelling predominates during the summer (Parsons 1987), although the duration and strength of summer upwelling varies locally with the wind field, so that some areas of the shelf may only experience upwelling regimes for 1 to 2 months of the year (Reed and Schumacher 1987). On the northern Gulf of Alaska shelf, upwelling not attributable to broad-scale physical forces may also be caused by localized wind stress curl (Hermann pers comm. 2005). In addition, mesoscale (~200 km diameter) eddies form as a result of both bottom topography (e.g. the Sitka eddy) and the interaction of the Alaska Stream and Alaska Coastal Current (Reed and Schumacher 1987, Hermann *et al.* 2002, Ladd *et al.* 2005). These eddies are most common in spring and are often anticyclonic (Hermann *et al.* 2002), therefore producing localized downwelling where they occur. Thus the physical conditions on the Gulf of Alaska continental shelf are complex and variable at several temporal and spatial scales, so we might expect considerable spatial and temporal variation in the biological community due to physical forcing alone, in addition to variability imposed by biological dynamics.

Changes in the Gulf of Alaska continental shelf assemblage of benthic invertebrate and fish predators, including groundfish, invertebrates, and salmon, have been demonstrated and at least hypothetically attributed to climate regime shifts (Orensanz *et al.* 1998, Anderson and Piatt 1999, Mantua *et al.* 1997, Francis *et al.* 1998, Hare and Mantua 2000). The proposed mechanism for climate change forcing the observed change in productivity at higher trophic levels often involves “bottom up” forcing due to a change in phytoplankton and zooplankton production in response to changed physical condition such as mixed layer depth and temperature (Francis *et al.* 1998). There have been several studies which have modeled a lower trophic level response to changes in mixed layer depth and temperature associated with climate change: Polovina *et al.* (1995) used the 1985 Evans and Parslow model, and Haigh *et al.* (2001) used a more complex combination of the Evans and Parslow (1985) model and the Fasham (1995) model which included a detrital loop to evaluate the response of pelagic plankton communities to physical changes associated with decadal climate oscillations. However, none of these studies address the Gulf of Alaska shelf ecosystem specifically, where the observed changes in shrimp and groundfish productivity have occurred. The lack of a clear PDO signal in the physical conditions on the continental shelf (Stabeno *et al.* 2004) makes physically mediated bottom-up forcing arguments difficult to support by the mechanisms listed above for the open oceanic Gulf of Alaska. Further, no direct evidence of increased primary and secondary productivity within the shelf ecosystem has been identified in relation to the 1977 regime shift, in part because the time series are inadequate to address the question. However, knowing that large scale physical shifts have occurred, and finding that fishing mortality contributes relatively little to some groundfish stock’s total mortality and production, the regime shift paradigm finds more and more support through correlative analyses despite a modest supply of mechanistic connections.

4.1.2 Climate and Biological Regime Shifts

There is evidence for past climate regime shifts[10] and ecosystem responses to those shifts in the EBS and GOA (mid-1940s, 1977 and 1989); although evidence for a recent climate regime shift (1999) is unclear. Based on basin-wide North Pacific climate-ocean indices, there appear to have been major climate/ocean regime shifts in the mid-1940s and in 1976/77, and a minor climate regime shift in 1988/89 (Boldt 2005a, Hare and Mantua 2000, King 2005). For the earlier climate regime shifts, the mid-1940s and 1977, the pattern of sea surface temperature spatial variability implied a west-east dipole (Boldt 2004, Bond et al. 2003). After 1989, the pattern of spatial variability was dominated by a second pattern of sea surface temperature variability, which implied a north-south dipole. At regional scales the responses to these basin-scale changes may not be as coherent (Boldt 2004). Given the variability in the indices since 1998, there is some uncertainty if there was a climate regime shift in the late 1990s (Rodionov *et al.* 2005).

It is important to note that regimes cannot be characterized by only two possible states (King 2005). It is currently not possible to reliably predict when a regime shift will occur. There are multiple physical and ecological processes underlying regime shifts that are currently not well understood. Different statistical models fitted to data provide divergent predictions of future conditions (King 2005).

In addition to decadal-scale climate regime shifts global temperatures are increasing and are expected to have profound impacts on arctic and sub-arctic ecosystems. See section on Global Climate Change.

Some investigators have argued that natural fluctuations or cycles in physical and biological characteristics of marine ecosystems may not necessarily affect higher trophic levels because of strategies for survival they have evolved to buffer them against environmental uncertainty. Based on their analyses of possible causes of the sea lion decline, Pascual and Adkison (1994) concluded that environmental cycles were unlikely to have caused declines of Steller sea lions of the magnitude and duration observed. Shima *et al.* (2000) did a comparative analysis of population dynamics of four species of pinnipeds in similar variable environments (Steller sea lions in the Gulf of Alaska, Cape fur seals in the Benguela Current, harp seals in the Barents Sea, and California sea lions in the California Current) and found a major decline only for Gulf of Alaska Steller sea lions. They concluded that the success of the other populations suggests that pinnipeds in general have the ability to adapt to environmentally driven changes in prey resources, and that other factors were involved in the decline of Steller sea lions.

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[10] Atmospheric scientists often refer to decadal-scale changes in the climate as climate regime shifts. This type of regime shift is different than a biological regime shift. There are observed decadal-scale changes in some biological components of the North Pacific, and these are often referred to as biological regime shifts. Climate regime shifts may be observed in the physical conditions of the ocean and may affect the biology; however, the mechanisms by which the biology might be influenced are largely unknown. In this analysis we have attempted to distinguish between climate and biological regime shifts.

However, available evidence indicates that the magnitude of at least some components of the potential environmental change that may be facing the North pacific and Bering Sea ecosystems resulting from anthropogenic release of CO^2 (e.g., global warming and ocean acidification), coupled with the restrictions to Steller sea lion alternative terrestrial habitat use due to human settlement, is probably unprecedented (see below).

4.1.2.1 Bering Sea

The Bering Sea (BS) has shown three multidecadal regimes in surface air temperatures (SAT) fluctuations: 1921-1939 (warm), 1940-1976 (cold), and 1977-2005 (warm) (Rodionov *et al.* 2005). More recently in 2006 and 2007, conditions in the Bering Sea have been cooler than the previous six years, which were very warm. The Bering Sea was subject to a change in the physical environment and an ecosystem response after 1977, influenced by shifts in Arctic atmospheric circulation in the early 1990s, and persistent warm conditions since 2000 (see Tables 2 and 3 in Boldt 2005b). A major transformation, or regime shift, of the Bering Sea occurred in atmospheric conditions around 1977, changing from a predominantly cold Arctic climate to a warmer subarctic maritime climate as part of the Pacific Decadal Oscillation (PDO) (see Tables 2 and 3 in Boldt 2005b). Weather data beginning in the 1910s and proxy data (e.g. tree rings) back to 1800 suggest that, except for a period in the 1930s, the Bering Sea was generally cool before 1977, with sufficient time for slow growing, long-lived, cold-adapted species to adjust. A specific Arctic influence on the Bering Sea began in 1989, as a shift in polar vortex winds (the Arctic Oscillation – AO) reinforced the warm Bering conditions, especially promoting an earlier timing of spring meltback of sea ice. During 2000 - 2005, the climate patterns resulted in southwesterly wind anomalies and, hence, very warm atmospheric conditions in the Bering Sea (Stabeno and Overland 2007). The winds also resulted in a decreased ice extent, earlier ice melt, and warm ocean temperatures (Stabeno and Overland 2007). In 2006-2008, climate patterns have resulted in colder atmospheric conditions, cooler ocean temperatures and more sea ice that has persisted longer relative to 2000-2005 conditions (Stabeno and Overland 2007, Wang et al. 2007). A comprehensive report (NAS 1996) indicated that a combination of fishing and the 1977 shift in physical forcing caused a major reorganization of the marine ecosystem on the Bering Sea shelf over the following decade. Surveys show an increase in the importance of pollock to the ecosystem. The NAS (1996) report hypothesizes that fishing of large whales increased the availability of planktonic prey, fishing on herring reduced competition, and fishing on flatfish reduced predation. The modeling study of Trites *et al.* (1999) noted that the increase in pollock biomass could not be explained solely by trophic interaction from these removals, and favored environmental shifts as an explanation. While the physical shift after 1976 was abrupt and pollock biomass increased rapidly, the ecosystem adjustment probably took a prolonged period as relative biomass shifted within the ecosystem.

Some responses to the climate shift in 1989 were observed in the Bering Sea. Northern rock sole recruitment was relatively high in the mid-1980s due to favorable onshore larval advection (Wilderbuer et al. 2002), but the AO shift to weaker winds after 1989 reduced these favorable conditions and recruitment was lower (Overland *et al.* 1999). In five of seven years during 2001-2007, transport was again onshore towards favorable nursery areas, with corresponding above average recruitment of northern rock sole (Wilderbuer and Ingraham 2007).

Biodiversity measures (richness and evenness) of groundfish, excluding pollock, also appeared to shift in the late 1980s; indices decreased throughout the 1980s and were stable in the 1990s (Hoff 2003). Jellyfish, which share a common trophic level with juvenile pollock and herring, may have played a role in the ecosystem adjustment as their biomass increased exponentially beginning in the late 1980s, but decreased to lower levels in 2001-2007 (see Tables 2 and 3 in Boldt 2007).

As global temperatures increase, impacts of those temperatures will likely occur in the Bering Sea (see discussion of global warming below). Warm conditions tend to favor pelagic over benthic components of the ecosystem (Hunt *et al.* 2002, Palmer 2003). Cold water species, i.e. Greenland turbot, Arctic cod, snow crab and a cold water amphipods, are no longer found in abundance in the SE Bering Sea, and the range of Pacific walrus is moving northward. While it is difficult to show direct causality, the timing of the reduction in some marine mammal abundance levels suggests it is due to some loss of their traditional Arctic habitat. Although physical conditions appear mostly stable over the last decade, the warmest water column temperatures occurred in 2001 to 2005 on the southeast Bering Sea shelf, despite considerable year-to-year variability in the AO and PDO.

The overall climate change occurring in the Arctic, as indicated by warmer atmospheric and oceanic temperatures and loss of 15% of sea ice and tundra area over the previous two decades, is hypothesized to make the Bering Sea less sensitive to the intrinsic climate variability of the North Pacific. Indeed, when the waters off of the west coast of the continental U.S. shifted to cooler conditions after 1998, the subarctic did not change (Victoria pattern), in contrast to three earlier PDO shifts in the 20th century.

4.1.2.2 Aleutian Islands

Climatic conditions have varied between the east and west Aleutian Islands. Around 170 deg W: to the west there was a long term cooling trend in winter between 1956 and 2002, while to the east conditions change with the PDO (Rodionov et al. 2005). This location is also near the first major pass between the Pacific and Bering Seas for currents coming from the east. Biological conditions in the Aleutian Islands have changed since the 1980s, and it is too soon to discern if there was a change associated with the 1998 climate regime shift. Pollock and Atka mackerel productivity do not appear to vary on a decadal-scale. Pacific Ocean perch population dynamics vary on a decadal-scale. For example, Pacific Ocean perch survival changed at the approximate times of climate regime shifts, 1975 and 1989. However, there is not enough information on the early life history of Pacific Ocean perch to define a mechanism for the observed variations.

4.1.2.3 Gulf of Alaska

Evidence suggests there were climate regime shifts in 1977 and 1989 in the North Pacific. Ecosystem responses to these climate shifts in the Gulf of Alaska (GOA) were strong after 1977, but weaker after 1989. Initially it was hypothesized that there was also a climate regime shift in 1998/99. However, evidence for this shift is unclear. Variation in the strength of ecosystem responses to climate shifts may be due to the geographical location of the GOA in relation to the spatial pattern of climate variability in the North Pacific. Prior to 1989, climate forcing varied in an east-west pattern, and the GOA was exposed to extremes in this forcing. After 1989, climate forcing varied in a north-south pattern, with the GOA as a transition zone between the extremes in this forcing.

There were both physical and biological responses to climate regime shifts in the GOA. However, the primary reorganization of the GOA ecosystem occurred after the 1977 climate shift. After 1977, the Aleutian Low intensified. This resulted in stronger Alaska current, warmer water temperatures, increased coastal rain, and, therefore, increased water column stability. The optimal stability window hypothesis suggests that water column stability is the limiting factor for primary production in the GOA (Gargett 1997). A doubling of zooplankton biomass between the 1950s- 1960s and the 1980s indicates production was positively affected after the 1977 climate regime shift (Brodeur and Ware 1992). Recruitment and survival of salmon and demersal fish species also improved after 1977 (see Tables 4 and 5 in Boldt 2005b). Catches of Pacific salmon in Alaska increased, recruitment of rockfish (Pacific ocean perch) increased, and flatfish (arrowtooth flounder, halibut, and flathead sole) recruitment and biomass increased. Individual groundfish stock survival and recruitment indices showed inconsistent responses to the 1977 shift. However, combined standardized indices of groundfish survival and recruitment indicated that overall groundfish productivity increased after the 1977 climate shift (Mueter et al. 2007). There are indications that shrimp and forage fish, such as capelin, were negatively affected after 1977, as survey catches declined dramatically in the early 1980s (Anderson 2003; see Tables 2 and 3 in Boldt 2005b). The decline in marine mammal and seabird populations, observed after 1977, may have been related to the change in forage fish availability (Piatt and Anderson 1996).

After 1989, water temperatures were cooler and more variable in the coastal GOA, suggesting production may have been lower and more variable. After 1989, British Columbia (BC) salmon catches and survival were low and Queen Charlotte Island (northern BC) herring declined. Salmon catches in Alaska, however, remained high. Groundfish recruitment and survival, as measured by combined standardized indices, showed inconsistent responses to the 1989-climate shift (Mueter et al. 2007). Groundfish biomass trends that began in the early 1980s continued, with increases in flatfish biomass. By the late 1980s arrowtooth flounder, rather than walleye pollock, were the dominant groundfish. Large groundfish biomass estimates resulted in negative recruit per spawning biomass anomalies of demersal fish.

Initially, there was some indication that the GOA ecosystem may have weakly responded to the suspected 1998 climate regime shift. Increased storm intensity from 1999 to 2001 resulted in a deeper mixed layer depth in the central GOA, and coastal temperatures were average or slightly below average. After 1998, coho survival increased in southern BC, shrimp catches increased in the northern GOA (but have since declined again in 2003), and the 1999 year class of both walleye pollock and Pacific cod was strong in the northern GOA.

4.1.3 Changes in Biological Productivity

Conners *et al.* (2002) present an analysis of bottom trawl survey data from 1963-2000. Three index areas with good survey coverage through the full time span were selected; one area includes Steller sea lion critical habitat north of Unimak Island. A robust index of median CPUE was used as an indicator of regional groundfish abundance. Time series for total catch and for several major groundfish groups showed substantial increases in the early- to mid-1980s in all three index areas (Figure 4.1). Time series for walleye pollock, Pacific cod, rock sole, flathead sole, cartilaginous fishes (skates) and benthic invertebrates showed substantial increasing trends. The timing of change in trawl CPUE is consistent with effects of the strong regime shift observed in climate indices in 1976-1977. The similarity in trends both across the region and across both commercial and unexploited groups suggests that a widespread reorganization of benthic and demersal food webs may have taken place. There is little evidence of similar biological responses to smaller climate shifts in the 1990s. These results are also consistent with recently documented shifts in ecosystem dynamics resulting from changes in ice cover and thermal structure in the eastern Bering Sea. This analysis indicates that there was a much higher biomass of groundfish at all three sites during 1980-2000 than in 1960-1980. These results provide strong evidence against the hypothesis that the decline of Steller sea lions was due entirely to a decrease in overall productivity of the eastern Bering Sea (NMFS 2006b).

The NMFS's bottom trawl survey does not effectively sample pelagic forage fishes such as capelin, herring, and eulachon, which are important prey fish for sea lions. Data from inshore surveys in the Gulf of Alaska (Anderson and Piatt 1999) suggest that abundance of these species declined dramatically following the 1976-77 regime shift. There are no data available on whether a similar decline occurred in the Bering Sea. It is entirely feasible that the reorganization in food webs indicated in the retrospective study also affected pelagic food webs or the balance of demersal/pelagic production. There does not appear to have been a substantial decline in overall productivity in the EBS, but there could well have been a substantial shift in how production is distributed through the food web.

From 1954 to 1998, Eastern Bering Sea (EBS) summer zooplankton biomass data, collected by the Hokkaido University research vessel T/S Oshoru Maru and re-analyzed by Hunt *et al.* (2002) and (Napp *et al.* 2002), showed no discernable trends in any of the four EBS geographic domains (Napp *et al.* 2002; see Figure 41 in Boldt 2005). The updated time series, however, depicts a strong decrease in biomass during 2000-2004. What is remarkable is that the decrease occurred in all four domains (see Figure 41 in Napp and Shiga 2005). Part of the decrease in biomass over the middle shelf may be due to recent decreases in the abundance of *Calanus marshallae*, the only "large" copepod found in that area (Napp, in prep.). It is not clear what might be the cause of declines in other regions.

Annual surplus production (ASP) indices, the sum of new growth and recruitment minus deaths from natural mortality, suggest high variability in groundfish production in the EBS and a decrease in production between 1978 and 2005 (see Fig. 110 Mueter 2007). Production in the GOA was much lower on average, less variable, and decreased slightly from 1978 to 2005 (Mueter 2007). Because trends in ASP indices are largely driven by variability in walleye pollock in the EBS, the results suggest a strong, significant decrease in aggregate surplus production of all non-pollock species from 1978 – 2005 (see Fig. 112 in Mueter 2007). The declines in production may be a density-dependent response to observed increases in biomass because theory suggests that surplus production will decrease as biomass increases above B_{MSY}, which has been the case for a number of flatfish species (e.g. rock sole, flathead sole) and rockfish species (Pacific ocean perch, northern rockfish; Mueter 2007). This may be indicative of a "top-down" phase in a larger ecosystem cycle (e.g. the Oscillating Control Hypothesis described for the eastern Bering Sea in Hunt *et al.* (2002), or the shift from bottom-up to top-down control described in Bailey (2000)). As shown in Figure 4.2, while the overall biomass of the main groundfish in the Bering Sea has increased since the late 1970s, the populations have also aged and grown larger; this trend is particularly pronounced in the 1990s. This aging population would be expected to have a decreased ratio of production to energy consumption, although this does not take into account possible importance of contributions of high natality individuals in the larger sizes.

4.1.4 Steller Sea Lion Prey Response to Climate and Regime Changes

4.1.4.1 Recruitment Response to Regime Changes

Eastern Bering Sea Pollock

To evaluate EBS pollock recruitment relative to a suite of putative regimes, sets of years were included within the integrated stock assessment model to provide estimates of uncertainty. For the period 1963-1976 the average age-1 recruitment appears to be substantively lower than that for all other periods. The coefficients of variation for these estimates were relatively low (except for the cohorts from 1999-2005). There appears to be evidence of higher recruitment post 1976 compared to the earlier period. Evidence of significant differences from subsequent putative regimes is apparently lacking based on an analysis of data through 2004. The most recent assessment (Ianelli et al. 2007) showed the time period between 2004-2006 to have extremely low recruitment, with 2004 and 2005 showing the lowest assessed recruitment since 1965, which has given rise to concerns that we may be entering a period of low recruitment associated with a warmer, ice-free southeastern Bering Sea. However, preliminary data (Ianelli et al. 2007) show that 2007 recruitment was closer to 1990s levels. The extremely warm, ice-free years in 2002-2005 may have contributed to low zooplankton biomass and low pollock survival during 2004-2005. 2006-2007 were cold years with extensive ice cover in the Bering Sea, although ice remained at historic lows in the Arctic in general. Determining the future of the Bering Sea pollock stock will require the close examination of climate models to predict whether 2002-2005 conditions were anomalously warm compared to future expectations or whether those years represent an expected future state of the climate with correspondingly poor conditions for pollock.

Gulf of Alaska pollock

Recruitment of pollock in the Gulf of Alaska is highly variable on multiple time scales (Dorn *et al.* 2005). On an interannual time scale, recruitment of Gulf of Alaska pollock is more variable (CV = 1.07) than Eastern Bering Sea pollock (CV = 0.64). Among North Pacific groundfish stocks with age-structured assessments, GOA pollock ranks third in recruitment variability after sablefish and Pacific Ocean perch (http://www.afsc.noaa.gov/refm/stocks/estimates.htm). Unlike sablefish and Pacific Ocean perch, pollock have a short generation time (<10 yrs), so that large year classes do not persist in the population long enough to have a buffering effect on population variability. High recruitment variability implies a large environmental component to forcing, since biotic factors such as density dependence or predation tend to change more gradually. On decadal time scales, there is also variability in pollock recruitment. Mean recruitment increased by approximately five times from the 1960s to the 1970s, then declined in the 1980s, declined further in the 1990s, but stabilized in 2000s.

In the Gulf of Alaska, climatic regime shifts occurred in 1977 and in 1989 based on persistent changes in Pacific Decadal Oscillation (PDO). As noted earlier, the term climatic regime shift refers to persistent changes in atmospheric conditions and the physical condition of the ocean, not to the biological response to those changes. Although correlation analyses (or other related approaches) can be used to relate climate forcing to biological response, often the mechanistic link must be hypothesized because environmental data are not available at appropriate temporal and spatial scales (Baumann 1998).

There are several hypotheses about how the 1977 regime shift might have affected pollock recruitment in the GOA. First, the shift from cool temperatures to warm temperatures may have favored better larval pollock survival through one or more indirect mechanisms (Bailey 2000). A second hypothesis is that the spring zooplankton bloom shifted earlier in the year, favoring winter spawners such as pollock (Andersen and Piatt 1999). A final hypothesis is the optimal stability "window" (Gargett 1997), which hypothesizes that changes in strength of the Aleutian Low associated with the 1977 regime shift affected water column stability, resulting in an increase in primary production in coastal areas of the Gulf of Alaska. While all of these hypotheses seem reasonable, oceanographic time series in the Gulf of Alaska are too short to establish observational proof. Further, Stabeno *et al.* (2004) did not find a strong PDO signal in physical conditions of coastal waters of the Gulf of Alaska, raising questions about the importance of basin-scale climatic patterns in physical forcing at spatial and temporal scales important to pollock recruitment.

A more important question is whether the pattern of pollock recruitment changed after the regime shift. Although pollock recruitment shows a clear pattern of increase and decline over the period 1959-2004, there are no obvious changes occurring immediately after the 1977 or the 1989 regime shift. The 1970's stand out as a decade of very strong recruitment for GOA pollock, but five out of the eight strong year classes (> 1.0 billion age-2 recruits) in the 1970's occur prior to 1977. In the twenty-seven years since 1980, strong year classes have recruited to the population every six years on average. However, no years with more than one billion age 2 recruits have been observed since 1991, and 2003-2005 were the second, third, and fourth lowest recruitments observed over the 1961-2007 time series. Average year classes were observed in 2006 and 2007, and are predicted for 2008 and 2009 (Dorn et al. 2007). Hollowed et al. (2001) found that GOA pollock exhibited higher incidence of strong recruitment during years when El Niño conditions propagated into the Gulf of Alaska, but did not find a relationship between the 1977 phase change in PDO and pollock recruitment. Support for the hypothesis that the climatic regime shift in 1977 resulted in improved conditions for pollock recruitment is not compelling.

Pacific cod

In the EBS Pacific cod model (Thompson et al. 2007), recruitment estimates are obtained for each year class from 1974 through 2006, and in the GOA Pacific cod model (Thompson et al. 2006), recruitment estimates are obtained for each year class from 1964 through 2004. In both the EBS and GOA models, the effects of the 1976-1977 regime shift are modeled explicitly by estimating separate median recruitment levels for the two portions of the time series.

The EBS Pacific cod model estimates median numbers at age 0 for the pre-1977 and post-1976 regimes at values of 149 million fish and 800 million fish, respectively (i.e., the pre-1977 median is 81% lower than the post-1976 median). Of the 13 pre-1977 cohorts, none of the point estimates exceed the post-1976 median, but the 95% confidence interval overlaps the post-1976 median in 2 cases (1974 and 1976). Of the 30 post-1976 cohorts, none of the point estimates fall below the pre-1977 median, and the 95% confidence interval overlaps the pre-1977 median in only 2 cases (1981 and 1987).

Given the structure of the EBS Pacific cod model and the existing data, there is virtually no chance that the pre-1977 median recruitment was as high as the post-1976 median. There is a 95% chance that the pre-1977 median was at least 76% lower than the post-1976 median, and a 99% chance that the pre-1977 median was at least 73% lower than the post-1977 median.

The GOA Pacific cod assessment estimates median numbers at age 0 for the 1964-1976 and 1977-2004 time periods at values of 87 million fish and 273 million fish, respectively (i.e., the pre-1977 median is 68% lower than the post-1976 median). Of the 13 pre-1977 cohorts, none of the 95% confidence intervals overlap the post-1976 median, and of the 28 post-1976 cohorts, none of the 95% confidence intervals overlap the post-1976 median.

The software used to create the GOA Pacific cod model differed from that used to create the EBS Pacific cod model. One of the differences pertains to the manner in which the pre-1977 median recruitment was estimated. Unfortunately, this difference means that the type of statistical comparison between pre-1977 and post-1976 medians described above for the EBS model cannot be conducted for the GOA model. Moreover, a rigorous statistical evaluation of the potential existence of regime shifts other than the 1977 shift is not possible in either the EBS model or the GOA model. As a first approximation, a simple, "difference between two means" test can be used to evaluate the existence of the 1977 regime shift in the GOA. The same test can also be applied to hypothesized 1988-1989 and 1998-1999 regime shifts in both the EBS and GOA. In all cases, however, it should be emphasized that some assumptions inherent in the test are being violated (e.g., the variances associated with the individual estimated recruitments are not equal). The results of these tests are shown below:

EBS
The 1988-1989 shift is significant at any level greater than about 42%.
The 1998-1999 shift is significant at any level greater than about 86%.

GOA
The 1976-1977 shift is significant at any level.
The 1988-1989 shift is *in*significant at any level.
The 1998-1999 shift is significant at any level greater than about 59%.

On the basis of the above, it appears that the difference in median/mean recruitment before and after the 1976-1977 regime shift is statistically significant at any reasonable level of significance (e.g., 1% or 5%) in both the EBS and GOA, but the differences in mean recruitment before and after the hypothesized 1988-1989 or 1998-1999 regime shifts are not. These results are similar to those obtained by Boldt and Conners (2004), with the exception that the assessment results available to Boldt and Conners did not include estimates of pre-1977 cohorts.

Atka mackerel

It is unclear to what extent if any, that recruitment of Atka mackerel follows expectations of good vs. bad environmental conditions based on regime shift theory. Until we understand the mechanisms, processes and environmental linkages that contribute to successful recruitment, we cannot know how recruitment is related to regime shift theory. The recruitment history of Atka mackerel is characterized by variable but fairly good recruitment throughout the time series of stock assessment estimates. The strong 1999 year class is most notable followed by the 1988, 1977 and 2001 year classes (Lowe *et al.* 2007). The most recent stock assessment estimates above average (greater than 20% of the mean) recruitment from the 1977, 1986, 1988, 1992, 1995, 1998, 1999, 2000, and 2001 year classes (Lowe *et al.* 2007). Based on basin-wide North Pacific climate indices, there appears to have been a major regime shift in 1976/77, and a minor regime shift in 1988/89 (Boldt 2005, Hare and Mantua 2000, King 2005). There is some uncertainty if there was a regime shift in 1999 given the variability in environmental indices since 1998 (Rodionov *et al.* 2005). These hypothesized regime shifts coincide with the three strongest Atka mackerel year classes, however, it should noted that the mechanisms which produce successful recruitment are unknown.

In an analysis by Boldt *et al.* (2004), climate regime-scale variability in recruit per spawner time series was not detected in groundfish (pollock, cod, and Aleutian Islands Atka mackerel). The conclusion from this analysis was that the survival of groundfish does not appear to be related to decadal-scale climate variability as defined by the hypothesized 1976/77, 1988/89, or 1998 years of regime shifts. In a more recent analysis, it was shown that individual groundfish stock survival and recruitment indices showed inconsistent responses to the 1977 shift; however, standardized indices of survival and recruitment for all groundfish combined indicated that overall groundfish productivity increased after the 1977 climate shift (Mueter et al. 2007).

4.1.4.2 Response of Major Pollock Spawning Aggregations

A comparative approach was used within the stock assessment to evaluate whether fishing impacts or other factors (i.e., environmental changes) were likely to have caused observed patterns of recruitment and biomass. Over the last 12 years, harvest rates in the three areas show good contrast (Ianelli *et al.* 2005a, Ianelli *et al.* 2005b, Dorn *et al.* 2005). The Bogoslof area has barely been fished at all during this period, but has shown the greatest percent decline. The continued decline in survey biomass after major fishery impacts ceased in 1991 is contrary to what would be expected if fishing within the Bogoslof area was the primary factor controlling stock abundance. Harvest rates have been similar between the GOA and EBS, and are low compared to fisheries for other gadids (Brander 2003). Survey biomass has been stable to slightly increasing in the EBS, but has declined in Shelikof Strait. The differing survey trends under similar fishing impacts is also contrary to what would be expected if fishing were the primary factor controlling stock abundance in the EBS and GOA.

An important question is why pollock abundance has declined in the Gulf of Alaska if pollock have been consistently harvested at less than F_{MSY}. This question was explored by "replaying" the population dynamics without fishing. The simplest approach is to replay the population dynamics with the same recruitment time series. This approach does not take into account the potential impact of fishing on recruitment due to changes in stock biomass (potentially fewer recruits at low stock size, or more cannibalism on pre-recruits at high stock size).

To evaluate the potential impact of higher spawning biomass, we also replayed the stock dynamics with a rescaled recruitment time series based on a stock-recruit relationship (NMFS 2006b).

Results, based on a single species perspective, showed that a significant decline of pollock abundance from the peak in the1980's would have occurred even without fishing (Figure 4.6). This suggests that other factors such as environmental variability may be a more significant driver for the stock abundance. Another explanation is that Gulf of Alaska pollock are extremely unproductive; however analysis of available stock-recruit data suggests that this alternative has relatively low probability (Dorn *et al.* 2003). Other factors include ecosystem dynamics which were considered above.

The relationship between both Bogoslof and Shelikof spawning aggregations and larger regional populations is not well established. There is no evidence that these aggregations are genetically distinct populations, and some exchange likely takes place between these aggregations and pollock populations in other parts of the eastern Bering Sea and the Gulf of Alaska. The extent of exchange is unknown. One possibility for observed pattern of decline in the Bogoslof area and in Shelikof Strait is a change in spatial patterns of spawning. Winter surveys of spawning aggregations in other parts of the Gulf of Alaska provide evidence a significant amount of pollock spawn outside of Shelikof Strait (Dorn *et al.* 2003, Dorn *et al.* 2005). Attempts have been made to identify environmental factors influencing the spawning migration into Shelikof Strait, but so far models with environmental variables have poor predictive power (Boldt *et al.* 2002). However, it is also possible that fishing may have impacted the Shelikof Strait spawning aggregation, but this is not predicted by the single species models which generally assume no negative impacts of removing large pre-spawning fish.

Based on the assessment results, recruitment variability is highest in the Bogoslof area (CV = 1.96), high in the Gulf of Alaska (CV = 1.07), and relatively stable in the eastern Bering Sea (CV = 0.64). The recruitment time series for the Bogoslof area is notable for an exceptionally strong 1978 year class that was still the most abundant year class at age 14 in the 1992 survey. High recruitment variability suggests a strong environmental component to forcing and a highly dynamic environment. The range of recruitment variability for pollock in the Gulf of Alaska, the Bogoslof area and the eastern Bering Sea is consistent with the observation that the Gulf of Alaska and Aleutian Island ecosystems are more open, dynamic systems than the eastern Bering Sea shelf.

Pollock have a relatively short generation time (<10 yrs[11]), so that large year classes do not persist in the population long enough to have a buffering effect on population variability. Therefore, the typical pattern of biomass variability for pollock stocks with high recruitment variability will be sharp increases due to strong recruitment, followed by periods of gradual decline until the next strong year class recruits to the population. Pollock in the Bogoslof area and in the Gulf of Alaska are more likely to show this pattern than other groundfish stocks in the North Pacific due to the combination of a short generation time and high recruitment variability.

A simulation model was used to evaluate stock biomass variability under the current harvest policy for Gulf of Alaska pollock. Simulations were conduced using a stock recruitment relationship such that $F_{MSY} = F_{35\%}$ and modeled recruitment variability and autocorrelation based on historical patterns. A graph of 1000-year subsample of a simulation run demonstrates that even for a harvest policy appropriate to stock productivity, variability around mean stock size will be large (Figure 4.7). A typical pattern of variability consists of a sharp increase in stock size due to the recruitment of one or more strong year classes, followed by a sustained decline. The observed decline in pollock abundance in the Gulf of Alaska does not appear unusual in the 1000-year subsample. These patterns can be obtained with a stationary stock-recruit relationship without invoking "regime shifts" or decadal shifts in stock productivity.

4.1.4.3 Response of Aleutian Islands Pollock to Environmental Changes and Fishing Prohibitions

Fishing for Aleutians Island pollock was prohibited in 1999 under the Steller sea lion conservation measures and was allowed again outside of critical habitat in 2005. The long term biomass trend for AI pollock had been decreasing until about 1999. Given the extensive closure area for this stock, it provides a unique opportunity to evaluate the effects of prohibiting fishing and observing how environmental conditions may naturally impact recruitment in the absence of fishing pressure.

Although the 2000 and 2002 summer bottom trawl surveys purport an increase in the pollock biomass in the Aleutian Islands area from the 1997 estimate (Table 4.3), these surveys are highly imprecise (CV = 28% and 38% respectively) and unreliable indices of abundance given

[11] Generation time is defined in this opinion as the average age of all reproductive females in the population. While average age of first reproduction is about 5 years of age for sea lions.

the variability in vertical distribution of Alaska pollock (Barbeaux *et al.* 2007). The 2004 summer bottom trawl survey shows a decline in abundance from 175,000 t in 2002 to 130,000 t in 2004, but the variance in the 2004 estimate (CV = 78%) is substantially higher than any previous estimate. These data are therefore insufficient to reliably discern abundance trends post-1999.

If the bottom trawl survey pollock abundance estimates were accurate and precise (q = 1.0), the catch levels estimated for the 1990's fishery would be unsustainable since under this assumption, the catch to biomass ratio would be between 28% and 75%. Indications are that the summer bottom trawl survey assesses only one component of the pollock stock in the Aleutian Islands and that this component may not include that taken by the fishery during winter. Also, the large catches during the early and mid-1990s primarily consisted of the 1978 year class and later the 1989 year class. The 1978 year class was only surpassed in catch weight by the 1989 year class in the 1995 fishery, but still remained a significant proportion of the catch through 1998 (7%). Pollock recruitment processes that led to the 1978 year-class event throughout the Aleutian Islands and eastern Bering Sea are poorly understood. The high variability in Aleutian Islands pollock recruitment is likely due to environmental conditions. The degree to which Aleutian Islands pollock abundance depends on movement from the EBS is also unknown. While it is possible that the EBS fishery causes some interception of potential Aleutian Islands recruitment, the exploitation rates within the EBS appear to be at sustainable levels (single species). It may be that the Aleutian Islands pollock stock depends on extremely favorable recruitment conditions such as that observed from 1978 and 1989.

In March and April 2006, 2007 and 2008 cooperative acoustics research surveys were conducted in the Aleutian Islands to assess the abundance of pollock in the region during spawning. Results show that, in the area surveyed, pollock biomass was lower than that available during the 1990s. Importantly, this study provides direct observation of localized abundance levels that have long been considered important for Steller sea lion conservation concerns. Current stock assessment models only deal with highly aggregated data and provide highly aggregated (and uncertain) results. In addition, the observed distribution and behavior under fishing suggests that a high catch-per-unit-effort could be achieved in this area even at low levels of abundance (NMFS 2006b). The pollock were concentrated on the shelf break and became more concentrated as the experimental fishery progressed in 2006. Such "hyperstability" in catch rates highlights the potential risk of interpreting commercial data. For example, depletion experiments may not be valid if the stock shows this stability in catch rates even though the actual biomass is small and being depleted, because the experiment would come to a completely opposite conclusion. These results are preliminary and further analysis is required before they can be considered conclusive. However, its does highlight the sensitivity of the Aleutian Islands to fishing pressure and the potential for long term impacts on the stock which may not be detectable from the single species perspective or through depletion experiments.

4.1.4.4 Changes in the Distribution of Important Prey

To evaluate changes in fish distribution for the Eastern Bering sea (pollock and Pacific cod) station-specific CPUE data from NMFS summer bottom-trawl surveys were used. Average CPUE was computed by 1 degree longitude by 0.5 degree latitude quadrangles and contoured to evaluate annual changes. Results indicate that interannual spatial variability is high for both pollock and Pacific cod, but with Pacific cod having a somewhat broader but lower density overall than pollock. Pollock summer bottom-trawl concentrations within Steller sea lion critical habitat area show considerable variability with some years having relatively low densities (e.g., 1982, 1988, 1991, 1997-1999, 2006) and of other years having high concentrations in critical habitat. In recent years, (since 2000) moderate densities of pollock have been consistently present in critical habitat (with the exception of 2006). For Pacific cod, the relative density in critical habitat was higher in the 1980s compared to later years.

To further summarize these densities relative to changes in fish distribution, central concentrations of pollock and Pacific cod were computed and mapped by year to ascertain if certain groups of years were different than others. This involved computing the CPUE-weight average location of pollock and Pacific cod. Results show that the centers of pollock distributions by year were more variable over years (spreading northwest to southeast) than that for Pacific cod. The 1993-1995 surveys show a tendency for pollock to be most dense towards the southeastern part while other years are mixed. This can be attributed to the relatively high abundance of the 1989 year class in the south-eastern regions. Pacific cod shows a marked north-northwest shift in distribution during the period 2000-2005. This is consistent with the lower densities of Pacific cod observed in the southeastern regions during these years.
The summer NMFS bottom-trawl survey data were also evaluated for CPUE patterns within and outside of Steller sea lion critical habitat areas. Mean values of CPUE were computed inside the critical habitat and compared to the mean CPUE outside of this region over time. Figure 4.15 shows a high degree of inter-annual variability of the relative CPUE inside Steller sea lion critical habitat compared to outside, especially for pollock (top panel). The bottom panel of this figure is the same data but aggregated into 5-year blocks. This shows that there appears to be a downward trend in Pacific cod CPUE within the critical habitat relative to outside. Pollock, on the other hand, appears to show a stable to increasing trend in relative CPUE within critical habitat.

The distribution of winter spawning pollock have shifted in the Bogoslof Island management district from near Bogoslof Island during the late 1980s and early 1990s to closer to Samalga pass and north-east of Umnak Island. Such relatively fine-scale shifts in spatial distribution suggests that environmental conditions may have changed to favor spawning habitat closer to the Aleutian Islands chain than in the past.

Shifts in distribution of pollock in the Aleutian Islands appear to coincide mostly with a connection to the “Aleutian Basin” stock (as indexed by the Bogoslof region) and that of the EBS shelf region. Specifically, the highest recorded historical catches occurred during winter months in the eastern most part. These pollock were thought to be comprised of mainly the 1978 and 1989 year classes and currently pollock abundance in the eastern region of the Aleutian Islands remains low, despite limited directed pollock fishing in this region since 1999.

The changes in distribution of Pacific cod in the Aleutian Islands rely on summer biennial bottom trawl surveys and these show a high degree of variability.

Atka mackerel in the Aleutian Islands region also shows considerable variability over time based on summer bottom trawl surveys. As with many groundfish species, Atka mackerel is particularly prone to having high variance estimates, especially when broken down to finer management areas. This is due to the patchy distribution of this species. Nonetheless, trends for Atka mackerel in general suggest increased abundances throughout their range, particularly in the eastern and western management areas. This abundance pattern extends in recent years into the GOA where directed fishing for Atka mackerel is prohibited.

Pacific cod in the GOA also show a high degree of CPUE variability (Figure 4.19). Pacific cod in general are thought to be relatively mobile groundfish species based on the tagging studies of Shimada and Kimura (1994). Results from evaluating GOA survey patterns are consistent with a mobile species. Apparent long-term shifts in GOA Pacific cod abundances from summer survey data are difficult to ascertain.

GOA pollock spatial distributions have been evaluated regularly, particularly for patterns of spawning concentrations. For example, the annual winter Shelikof Strait surveys of spawning pollock have traditionally been considered to represent the majority of the GOA stock. Modeling efforts of the population have shown that about 67% of the pollock spawning occurs in the Shelikof region (on average) and about 20% in the Shumagin Islands region with the balance in other locations. There are trends in these data that suggest the Shelikof Strait spawning contribution has been below average for a number of years (2002-2005; Dorn *et al.* 2005). Relative pollock biomass in the GOA during the summer shows variability among regions. In some years the majority of the biomass appears in the Kodiak Island region while in other years, the Shumagin region appears to have the highest levels.

4.1.5 Changes in the Carrying Capacity for Western DPS Steller Sea Lion

Populations can experience abrupt and dramatic declines because of dramatic reductions in environmental carrying capacity (Odum 1971). Periodic shifts in oceanic and atmospheric conditions may have major effects on the productivity and structure of North Pacific ecosystems, with cascading effects on some prey fish populations. The manner and mechanism by which such “regime shifts” and altered fish populations would affect marine mammals, including Steller sea lions, is poorly understood and remains unresolved. Large, natural variability often masks the effects of human activity on natural ecosystems and populations. Because of the complex relationships between wild populations, their physical environment, and their ecological relationships, it is extremely difficult to assign a populations' decline to a single cause.

The carrying capacity of the North Pacific for Steller sea lions likely fluctuates in response to changes in the environment (Hare *et al.* 1999, Overland *et al.* 1999, Stabeno *et al.* 2001, Benson and Trites 2002, Hunt *et al.* 2002, Shima *et al.* 2002, Trites and Donnelly 2003). Changes in the North Pacific fish community structure stemming from the regime shift in 1976-77 may have been substantial enough to result in a dominance of pollock and other gadids.

However, it is unclear whether this environmental variability and the associated diet shifts were outside the limits of natural variability in the history of Steller sea lions in the North Pacific and were principal factors in their population decline. Gadids have been and are likely to continue to be a principal component of the diet of sea lions. The 1976-77 regime shift likely affected species differently. In an analysis by Boldt *et al.* (2004) , climate regime-scale variability in recruit per spawner time series was not detected for pollock, Pacific cod, and Atka mackerel. It is likely that the groundfish community changes, with some regimes or time periods more/less favorable for sea lions. Current data does not support the theory that the regime shift of 1976-77 resulted in a total re-organization of the prey field for Steller sea lions[12]. Available evidence indicates that the current fish community structure is similar (in composition but not necessarily relative biomass amounts) to that of earlier time periods and changes in sea lion diets between regimes were unremarkable. Another shift may have occurred in 1989 and 1998 (Hare and Mantua 2000, Bond *et al.* 2003), yet sea lions may still be unable to acquire sufficient energy from their prey resources due to continued declines in natality observed through 2002 (as observed in the Central GOA; Holmes and York 2003, Fay 2004, Holmes *et. al. 2007*).

In addition to the environmental changes, the removal of prey by many fisheries increased markedly in the 1980s and could have exacerbated natural changes in carrying capacity, possibly in non-linear and unpredictable ways (Calkins 1998, Goodman *et al.* 2002, NRC 2006). As these groundfish fisheries expanded, numerous investigators expressed concern about the effects of the expanded fisheries on populations of pinnipeds and seabirds in the North Pacific Ocean (Alverson 1991, Ashwell-Erickson and Elsner 1981). Several populations of seabirds and pinnipeds declined from the early to mid-1980s. As a result, scientists and fishery managers began to debate the relative roles of the regime shift and the groundfish fisheries on trophic relationships in the BSAI and GOA (Lowry *et al.* 1982, Alaska Sea Grant 1993, NRC 2003, NRC 2006).

4.1.6 Global Climate Change and Ocean Acidification

Global Climate Change

Global air and ocean temperatures during this century and before are warming (IPCC 2007, see http://www.ipcc.ch), and evidence suggests that the productivity of the North Pacific is affected by changes in the environment (Quinn and Niebauer 1995, Mackas *et al.* 1998).

Increases in global temperatures are expected to have profound impacts on arctic and sub-arctic ecosystems, and some of these impacts have been documented over the last several decades. Specifically, (1) winter temperatures in Alaska and western Canada have increased as much as 3-4 ˚C over the past half century, (2) precipitation, mostly in the form of rain, has increased primarily in winter resulting in faster snowmelt, (3) sea ice extent has decreased about 8% over the past 30 years, with a loss of 15 to 20% of the late-summer ice coverage in the arctic, and (4) glacial retreat, particularly in Alaska, has accelerated contributing to sea level rise (ACIA 2004). These impacts, and others, are projected to accelerate during this century.

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[12] The reorganization is described in Anderson and Piatt (1999) and countered by Fritz and Hinckley (2005).

The effects of these changes to the marine ecosystems of the Bering Sea, Aleutian Islands, and the Gulf of Alaska, and how they may specifically affect Steller sea lions are uncertain. Warmer waters could favor productivity of certain species of forage fish, but the impact on recruitment dynamics of fish of importance to sea lions is unpredictable. Recruitment of large year-classes of gadids (e.g., pollock) and herring has occurred more often in warm than cool years, while the distribution (with respect to foraging sea lions) and recruitment of other fish (e.g., osmerids) could be negatively affected. Whether these patterns will continue as overall temperatures increase is uncertain, as are the effects on the duration and strength of atmospheric and oceanographic regimes (Trenburth and Hurrell 1994, Hare and Mantua 2000).

Climate-driven changes in productivity and community structure due to warming oceans may already be underway in the northern portion of the Bering Sea and Bering Strait, where sea ice plays a major role in structuring the food web and the ecosystem is particularly vulnerable to rapid system reorganization under global warming. Reduced seasonal sea ice cover, changing hydrographic conditions, and reduced primary production in the northern Bering Sea may be associated with apparent declines in ice-associated benthic species of mollusks and amphipods since the 1990s (Grebmeier *et al.* 2006). In addition, Benthic-feeding walrus, bearded seals, gray whales and diving sea-ducks such as Spectacled eider all maybe impacted by these changes, as are Arctic Native communities whose traditional subsistence culture has relied on these ice-associated mammals and birds for thousands of years. This ecosystem has short, simplified food chains; thus the potential for trophic cascades is higher. Warming seawater in the north could expand the range of groundfish from the south, putting more pressure on the benthic prey base. The northern Bering Sea may be poised for the sort of trophic cascade and system reorganization anticipated by the U.S. GLOBEC (Global Ocean Ecosystems) research program as a consequence of global warming at high latitudes (Grebmeier *et al.* 2006).

Warmer temperatures could shift the distribution of sea lions northward. The eastern DPS increased in size at a rate of approximately 3% per year from the early 1980s through 2004, despite a decline in the size of the breeding population at the southern extent of its range in California. All of the increase in the eastern DPS occurred north of California, and new rookeries established in the 1990s (White Sisters and Hazy Island) were near its northernmost extent in southeast Alaska.

As temperatures warm and global ice coverage decreases, sea levels will rise. This will directly affect terrestrial rookery and haulout sites currently used by Steller sea lions as well as those that may be used by a recovering population. Presumably, sea lions using terrestrial sites will simply move upslope as sea levels rise, assuming that the terrain at the site is suitable. However, sites on some islands with low relief (e.g., Agligadak Island) may be submerged. The net effect of a rise in sea level on overall terrestrial sea lion habitat amount or availability is uncertain, but at the projected rate it is unlikely to have a significant effect for many years.

Fluctuations or cycles in physical and biological characteristics of marine ecosystems may not necessarily affect higher trophic levels because of strategies for survival they have evolved to buffer them against environmental uncertainty. Based on their analyses of possible causes of the sea lion decline, Pascual and Adkison (1994) concluded that environmental cycles were unlikely to have caused declines of the magnitude and duration observed. Shima *et al.* (2000) did a comparative analysis of population dynamics of four species of pinnipeds in similar variable environments (Steller sea lions in the Gulf of Alaska, Cape fur seals in the Benguela Current, harp seals in the Barents Sea, and California sea lions in the California Current) and found a major decline only for Gulf of Alaska Steller sea lions. They concluded that the success of the other populations suggests that pinnipeds in general have the ability to adapt to environmentally driven changes in prey resources, and that other factors were involved in the decline of Steller sea lions.

There is growing concern about global climate change. Global air and ocean temperatures during this century and before are warming (IPCC 2007a, see http://www.ipcc.ch), and evidence suggests that the productivity of the North Pacific is affected by changes in the environment (Quinn and Niebauer 1995, Mackas *et al.* 1998)

Key relevant findings from the most recent report of the Intergovernmental Panel on Climate Change (IPCC) (2007b:2) include (bold text in original):

> **"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level**…"
>
> '…Eleven of the last twelve years (1995-2006) rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850). The 100-year linear trend (1906-2005) of 0.74 [0.56 to 0.92]°C1 is larger than the corresponding trend of 0.6 [0.4 to 0.8]°C (1901-2000) given in the Third Assessment Report (TAR) (Figure SPM.1). The temperature increase is widespread over the globe and is greater at higher northern latitudes."
>
> "Observational evidence4 from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases."
>
> Anthropogenic warming over the last three decades has likely had a discernible influence at the global scale on observed changes in many physical and biological systems.

Increases in global temperatures are expected to have profound impacts on arctic and sub-arctic ecosystems, and some of these impacts have been documented over the last several decades. Specifically, (1) winter temperatures in Alaska and western Canada have increased as much as 3-4 ˚C over the past half century, (2) precipitation, mostly in the form of rain, has increased primarily in winter resulting in faster snowmelt, (3) sea ice extent has decreased about 8% over the past 30 years, with a loss of 15 to 20% of the late-summer ice coverage in the arctic, and (4) glacial retreat, particularly in Alaska, has accelerated contributing to sea level rise (ACIA 2004). These impacts, and others, are projected to accelerate during this century. Solomon et al. (2009) concluded that:

> "…the climate change that takes place due to increases in carbon dioxide concentration is largely irreversible for 1,000 years after emissions stop…Among illustrative irreversible impacts that should be expected if atmospheric carbon dioxide concentrations increase from current levels near 385 parts per million by volume (ppmv) to a peak of 450–600 ppmv over the coming century are…inexorable sea level rise. Thermal expansion of the warming ocean provides a conservative lower limit to irreversible global average sea level rise of at least 0.4–1.0 m if 21st century CO_2 concentrations exceed 600 ppmv and 0.6–1.9 m for peak CO_2 concentrations exceeding ≈1,000 ppmv. Additional contributions from glaciers and ice sheet contributions to future sea level rise are uncertain but may equal or exceed several meters over the next millennium or longer.

The effects of these changes on the marine ecosystems of the Bering Sea, Aleutian Islands, and the Gulf of Alaska, and how they may specifically affect Steller sea lions and key elements of sea lion critical habitat are still uncertain and will depend on many factors, not the least of which is how much warming occurs, the extent of sea level rise, and effects on ocean chemistry, currents, and oceanographic processes. Warmer waters could favor productivity of certain species of forage fish, but the impact on recruitment dynamics of fish of importance to sea lions is unpredictable. Recruitment of large year-classes of gadids (e.g., pollock) and herring has occurred more often in warm than cool years, while the distribution (with respect to foraging sea lions) and recruitment of other fish (e.g., osmerids) could be negatively affected. Whether these patterns will continue as overall temperatures increase is uncertain, as are the effects on the duration and strength of atmospheric and oceanographic regimes (Trenburth and Hurrell 1994, Hare and Mantua 2000).

Climate-driven changes in productivity and community structure due to warming oceans may already be underway in the northern portion of the Bering Sea and Bering Strait, where sea ice plays a major role in structuring the food web and the ecosystem is particularly vulnerable to rapid system reorganization under global warming. Reduced seasonal sea ice cover, changing hydrographic conditions (Stabeno and Overland 2007), and reduced primary production in the northern Bering Sea may be associated with apparent declines in ice-associated benthic species of mollusks and amphipods since the 1990s (Grebmeier *et al.* 2006). Species of ice-dwelling mammals, including the polar bear, and various ice seals have been identified as threatened (polar bears) or potentially threatened (petitioned for listing under the ESA and currently undergoing review to determine status) by the decrease in habitat caused by climate change. On May 15, 2008, the Fish and Wildlife Service published a Final rule to list the polar bear (*Ursus maritimus*) as threatened under the ESA. In the Final Rule (73 FR 28212), the FWS found that, "…based upon the best available scientific and commercial information, that polar bear habitat—principally sea ice—is declining throughout the species' range, that this decline is expected to continue for the foreseeable future." This ecosystem has short, simplified food chains; thus the potential for trophic cascades is higher. Warming seawater in the north could expand the range of groundfish from the south, putting more pressure on the benthic prey base. The northern Bering Sea may be poised for the sort of trophic cascade and system reorganization anticipated by GLOBEC as a consequence of global warming at high latitudes (Grebmeier *et al.* 2006).

Warmer temperatures could shift the southern end of the Steller sea lion range northward. The eastern DPS increased in size at a rate of approximately 3% per year from the early 1980s through 2004, despite a decline in the size of the breeding population at the southern extent of its range in California. All of the increase in the eastern DPS occurred north of California, and new rookeries established in the 1990s (White Sisters and Hazy Island) were near its northernmost extent in southeast Alaska.

As temperatures warm and global ice coverage decreases, sea levels will rise. This will directly affect terrestrial rookery and haulout sites currently used by Steller sea lions as well as those that may be used by a recovering population. Presumably, sea lions using terrestrial sites will simply move upslope as sea levels rise, assuming that the terrain at the site is suitable. This is not the case at some sites. Sites on some islands with low relief (e.g., Agligadak Island) may be submerged. The net effect of a rise in sea level on overall terrestrial sea lion habitat amount or availability has not been well-studied. Neither the percentages or locations of sites potentially affected over different timeframes, and under different assumptions about sea level rise, are documented.

Ocean Acidification

Ocean acidification is a threat to ocean ecosystems related to global climate change and CO2 emissions. The IPCC (2007a:52): summarized that;

> The uptake of anthropogenic carbon since 1750 has led to the ocean becoming more acidic…Projections based on SRES scenarios give a reduction in average global surface ocean pH of between 0.14 and 0.35 units over the 21st century. While the effects of observed ocean acidification on the marine biosphere are as yet undocumented, the progressive acidification of oceans is expected to have negative impacts on marine shell-forming organisms…and their dependent species.

Anticipated pH changes will likely exceed current regional and seasonal variability (IAP 2009). The Royal Society (2005:vi) pointed out that “Other calcifying organisms that may be affected are components of the phytoplankton and the zooplankton, and are a major food source for fish and other animals.”

The potential effects and the specific timeframes for effects of ocean acidification on North Pacific ecosystems specifically are uncertain. However, in June 2009, the Interacademy Panel on International Issues (IAP 2009) stated that:

> “The high CO2 waters in polar and upwelling regions such as the eastern Pacific and Bering Sea for example, will experience low pH more rapidly than other regions…The ocean chemistry changes projected will exceed the range of natural variability, which is likely to be too rapid for many species to adapt to. Many coastal animals and groups of phytoplankton and zooplankton may be directly affected with implications for fish, marine mammals and the other groups that depend on them for food…The Impacts of these changes on oceanic ecosystems…cannot yet be estimated accurately but they are

potentially large…Although some species may benefit, most are adapted to current conditions and the impacts on ocean biological diversity and ecosystem functioning will likely be severe.

4.1.7 Removals of Large Whales and other Marine Mammals

4.1.7.1 Harvest of Northern Fur Seals

Commercial harvests of marine mammals in the Bering Sea began with the industrial harvest of northern fur seals in the Pribilof Islands in the late 1700s. The size of the fur seal population on the Pribilofs was estimated at 2.5 million animals (Kenyon *et al.* 1954). From its beginning until about 1835, commercial harvests of these fur seals were "extravagant, wasteful, and largely unrecorded" (Kenyon *et al.* 1954). By 1803, about 800,000 skins had accumulated in storehouses on the Pribilofs, 700,000 of which "were thrown into the sea as worthless."

By 1834, the northern fur seal population had declined to less than 1,000,000 animals, which resulted in a seven-year ban on killing fur seals to allow the population to recover. From the 1840s to the 1860s, the harvest of fur seals increased from 10,000 animals per year to about 75,000 animals. In 1868, when the U.S. first occupied the Pribilof Islands, 242,000 fur seals were harvested. From 1870 to 1909, commercial companies from the U.S. conducted the fur seal harvest accompanied by the onset of pelagic sealing.

The practice of pelagic sealing was not selective and resulted in the death of a high percentage of pregnant, female fur seals. From the 1860s to about 1911, more than 950,000 fur seals were taken by pelagic sealers. At the same time, more than 2,900,000 fur seals were taken on the Pribilof Islands. `The combination of pelagic sealing and land-based sealing dramatically reduced the size of the fur seal population: by 1897, the fur seal population had been reduced to about 400,000 animals; by 1911, it had been reduced to about 215,000 animals. Because the takes were greatly reducing the fur seal stock, Great Britain (for Canada), Japan, Russia, and the United States ratified the Treaty for the Preservation and Protection of Fur Seals and Sea Otters in 1911. The treaty prohibited pelagic sealing and required a reduction in the taking of seals on the land.

From 1912 to the mid-1950s, the population slowly increased to about 1,500,000 animals with a harvest of about 60,000 male seals each year. In the early 1950s, biologists realized that the fur seal population had ceased to grow and agreed to experiment with increasing the harvest of male fur seals and begin another harvest of female fur seals in the hope that the fur seal population would increase further. In 1953, the harvest of female fur seals began with the death of about 850 female fur seals. This harvest peaked in 1957, with 47,413 animals. From its discovery until the mid-1950s, more than 7.8 million fur seals were taken in commercial harvests. In 1957, the signatories of the 1911 Treaty ratified a new agreement, the Interim Convention on the Conservation of North Pacific Fur Seals, for the conservation, research, and harvesting of fur seals. About 18,000 female fur seals were killed each year from 1963 to 1968.

When this experiment ended, more than 300,000 female fur seals had been killed in an attempt to increase the productivity of the population and, as a result, the size of the commercial harvest (Kenyon *et al.* 1954). The harvest did not increase the population's productivity as expected; instead, pup production on St. Paul Island declined by 7 percent per year from 1975 to 1983 and production on St. George declined by 6 percent per year from 1973 to 1990. From 1950 to 1988, the fur seal population declined by over 50 percent (to about 1 million animals).

The authority of the 1957 Convention was extended in 1963, 1969, 1976 and 1980. Under the terms of the 1980 extension, the Convention expired on October 14, 1984. In consultation with the U.S. Departments of State and Justice, and the Marine Mammal Commission, the United States declined to sign an extension. It was determined that no commercial harvest could be conducted under existing domestic law and, therefore, the commercial harvest on St. Paul Island was terminated. Management of the fur seals then reverted to the MMPA. Accordingly, on July 8, 1985, NMFS issued an emergency interim rule to govern the subsistence taking of fur seals for the 1985 season under the authority of section 105(a) of the Fur Seal Act. A final rule was published on July 9, 1985.

On June 17, 1988, NMFS declared the stock of northern fur seals on the Pribilof Islands to be depleted under the MMPA. The MMPA defines a species, population, or stock as depleted if it falls below its optimum sustainable population (OSP). The lower bound of OSP for northern fur seals is thought to be at least 60 percent of the carrying capacity level. The Pribilof Islands population was designated depleted because it declined to less than 50 percent of levels observed in the late 1950s, and no compelling evidence suggested that carrying capacity has changed substantially since the late 1950s.

The Pribilof Islands population has continued to decline since the depleted listing. Between 1998 and 2004 estimated pup production declined at 6.2 percent per year (SE = 0.78 percent, P = 0.01) on St. Paul Island, and at 4.5 percent per year (SE = 0.45 percent, P = 0.01) on St. George Island. The 2004 estimate of pup production on St. Paul Island is comparable with the level observed in 1921, while on St. George it is below the level observed in 1916. Recent satellite telemetry studies indicate lactating female and juvenile male northern fur seals are central place foragers while in the Bering Sea. These studies also suggest separation of Bering Sea foraging areas defined by the central breeding area of departure for fur seals.

Changes in the quantity and/or quality of available prey may also influence the health and fitness of individual fur seals. Important fur seal prey includes pollock, small schooling fish, and gonatid squid. The importance of any particular prey category depends on the sampling location and may be related to biases in the method used to assess prey importance. Walleye pollock and squid are important fur seal prey in the eastern Bering Sea with the addition of Pacific herring, Pacific sandlance, and capelin in the Gulf of Alaska and Pacific Ocean. The abundance has changed for major fish species across the entire range of fur seals. Whether and what extent fish abundance was affected by fishing or environmental change is unknown. How alteration of fish abundance influences population trends of the Eastern Pacific stock is also unknown. The complexity of ecosystem interactions and limitations of data and models make it difficult to determine specific effects on the fur seal population.

The Fur Seal Conservation Plan reviews and assesses the known and possible factors influencing northern fur seals in Alaska; it also contains pertinent information on fur seals breeding in California and Russia. Natural factors influencing the population include predation, parasitism, disease, and environmental change. Human-related factors influencing the population include subsistence harvests, direct and indirect effects of commercial fishing, marine debris, poaching, pollution, vessel and aircraft traffic, tourism, coastal development, noise, and oil and gas activities.

4.1.7.2 Harvest of Large Cetaceans

By the late 1800s, commercial whaling had severely reduced the population of bowhead whales in the Bering and Chukchi Sea and had left the Pacific right whale population nearly extinct. The modern era of pelagic whaling in the north Pacific began in 1952, with a single factory ship operating off Asia. From 1954 to 1961, only three factory ships operated, but this type of whaling extended eastward to the American side of the Pacific. In 1963, the arrival of seven factory ships from Japan and USSR to whaling grounds in the north Pacific partially resulted from the protection of blue whales in the Antarctic and strict quotas on other Antarctic species. These pelagic whalers concentrated on humpback whales in the early 1960s, switched to fin whales in the mid-1960s, then switched to sei whales in the late 1960s. In 1970s, whalers in the north Pacific focused on hunting sperm whales and took between 8,000 to 10,000 per year during that period. From the 1950s to the 1970s, an estimated 5,671 blue whales, more than 21,000 fin whales, 40,000 sei whales, 30,143 humpback whales, and 210,000 sperm whales had been killed in the North Pacific Ocean.

Native Alaskans harvested whales in the eastern north Pacific for many years prior to the arrival of commercial whalers in the 19th century. The Inuit of the Bering Sea coast of Alaska have been whalers for centuries. Aboriginal whaling took place in three main areas in the eastern north Pacific (1) the west and northwest coasts of Alaska, (2) the Aleutian Islands and the Alaska Peninsula, and (3) the coasts of Vancouver Island and Washington.

The Aleuts of the Aleutian Islands and the Alaska Peninsula hunted whales with hand-thrown spears. They likely harvested humpback whales, gray whales and possibly right whales. Along the coast of British Columbia and Washington, whales were hunted by Nootka, Makah, Quilleute, and Quinault tribes, who targeted gray and humpback whales, and possibly right whales. The number of whales that were taken in these fisheries is unknown (Scarff 1986).

4.2 Natural Factors Affecting the Status of Steller Sea Lions in the Action Area

4.2.1 Climate and Oceanography

Periodic shifts in oceanic and atmospheric conditions appear to have had major effects on the productivity and structure of North Pacific ecosystems (Francis and Hare 1994, Francis *et al.* 1998, Hunt *et al.* 2002, Mackas *et al.* 1998, Anderson and Piatt 1999, Trites *et al.* 2006a) with cascading effects on some prey fish populations (Quinn and Niebauer 1995, Hollowed and Wooster 1992, 1995). For example, the size of available habitat for pollock, one of the primary prey species of Steller sea lions, reportedly increased with changes in the mixed layer depth in the Gulf of Alaska associated with climatic changes during the 1980s (Shima *et al.* 2000). Increases in pollock and other gadids (e.g. Pacific cod) in the Gulf of Alaska and Bering Sea (Alverson 1992), and their relatively low nutritional quality (Alverson 1992, Rosen and Trites 2000a) led to the "junk food hypothesis" for the decline of the western DPS of Steller sea lion.

In the junk food hypothesis, the quantity of prey available to the declining population of Steller sea lions was thought to be high overall, but the prey community switched from one dominated by high energy prey (e.g., herring and osmerids) to low energy species (e.g., gadids and flatfish; Alverson 1992, Rosen and Trites 2000a). As originally articulated by Alverson (1992), pollock and other gadids were presumed to be equally poor foods for all age classes of sea lions (i.e., both juveniles and adults). However, results of subsequent feeding experiments, mathematical models, and field observations suggested that adult sea lion growth and condition should be relatively unaffected by the low energy content of gadids (Rosen and Trites 2000b, 2004, Trites 2003, Trites *et al.* 2006a, Malavear 2002). Instead, low energy prey may detrimentally affect juvenile Steller sea lions more than mature individuals due to their relative inexperience at foraging (Merrick and Loughlin 1997), their higher relative energy requirements (Winship *et al.* 2002), an upper limitation on the amount of food that a sea lion can physically digest to meet its daily energy requirements (Rosen and Trites 2004), or the availability of sufficient prey (Malavear 2002).

Fritz and Hinckley (2005) concluded that patterns and time series of fish abundance, fish recruitment, and sea lion food habits did not support the hypothesis that the regime shift triggered changes in the prey community that, on their own, would have been deleterious to Steller sea lions. In addition, feeding experiments at the Alaska SeaLife Center have shown no negative consequences to juvenile sea lions fed only pollock (Calkins *et al.* 2005). This is consistent with published studies showing that there are no different effects between high-lipid and low-lipid (or low-protein and high-protein) prey on sea lion body composition when animals are able to consume sufficient prey to meet their energy demands (Rosen and Trites 2004, 2005).

It is likely that Steller sea lions may have lived through many climate/biological regime shifts in the few million years that they have existed. What may be different about this most recent shift (1977-78) is the coincident development of extensive fisheries targeting the same prey that sea lions depend on during warm regimes. Fisheries in the Bering Sea and Gulf of Alaska expanded enormously in the 1960s and 1970s. The existence of a strong environmental influence on sea lion trends does not rule out the possibility of significant fisheries-related effects. The cause of the sea lion decline need not be a single factor. To the contrary, strong environmental influences on Gulf of Alaska and Gulf of Alaska ecosystems could increase the sensitivity of sea lions to fisheries or changes in those ecosystems resulting from fisheries.

Given an 80% reduction in the western population of Steller sea lions and the lack of evidence suggesting sustained high levels of anthropogenic removals, it is likely that the environmental carrying capacity has been reduced either through natural environmental changes or human induced changes. Given the equivocal data surrounding the dietary needs of Steller sea lions, the consequences of climate regime shifts, and massive population declines, it is highly unlikely that natural environmental change has been the sole underlying cause for the decline of

Steller sea lions. Therefore, this consultation looks to other possible causes of the decline recognizing that environmental change is an important component in this equation, and may combine with other factors to contribute to the past and continuing decline of Steller sea lions.

4.2.2 Disease, Parasites, and Toxic Substances

The effects of disease parasites and toxins on Steller sea lions were discussed in detail in Section 3. Available serologic evidence does not support the likelihood that a disease epidemic occurred during the sea lion decline of the late 1970s and 1980s; however, due to sampling limitations the possibility can not be excluded completely. Although sea lions have recently been exposed to several endemic disease agents that could potentially impede recovery, the only available data are the prevalence of antibodies to the disease agents, but the potential for those agents to cause disease among Steller sea lions has not been documented. Disease and parasitism are common in all pinniped populations and have been responsible for major die-offs (e.g., Osterhaus *et al.* 1997), but such events are usually relatively short-lived and provide more evidence of morbidity or mortality. The potential for parasitism to have a population level affect on sea lions is largely unknown. Although parasites may have little impact on otherwise healthy animals, effects could become significant if combined with other stresses. Available information does not suggest that the sea lion decline was caused by parasitic infections, although there has not been adequate research to assess the current relative nature and magnitude of parasitism in sea lion populations. The ramifications of disease and parasitism remain a concern, both as primary and secondary problems, but do not appear to be significant impediments to recovery at this time or on the basis of the information currently available.

At present, there is not enough information to determine what role, if any, exposure to contaminants plays in the health, survival and recovery of Steller sea lion populations. In the Recovery Plan, NMFS (2008) concluded that toxic substance exposure posed a medium risk to the recovery of the western DPS of Steller sea lions and concluded also that there is a high level of uncertainty associated with that statement. Research focused on this topic could help our understanding of factors that are impacting recovery in the western DPS.

Toxic substances can impact animals in two major ways. First, the acute toxicity caused by a major point source of a pollutant (such as an oil spill or hazardous waste) can lead to acute mortality or moribund animals with a variety of neurological, digestive and reproductive problems. Second, toxic substances can impair animal populations through complex biochemical pathways that suppress immune functions and disrupt the endocrine balance of the body, causing poor growth, development, reproduction and reduced fitness. Toxic substances come in numerous forms, with the most-recognized being the organochlorines (OCs; mainly PCBs and DDTs), heavy metals and polycyclic aromatic hydrocarbons (PAHs). There are also a number of "emerging" contaminants, e.g., flame retardant polybrominated diphenyl ethers (PBDEs), which could also be impacting marine mammals (de Wit *et al.* 2002).

Aside from the Exxon Valdez Oil Spill in 1989, which occurred well after the Steller sea lion decline was underway, no other events have been recorded that support the possibility of acute toxicity leading to substantial mortality of Steller sea lions (Calkins *et al.* 1994). However, results from several studies, both published and still being conducted, do not permit the complete rejection of toxic substances as a factor that may currently impact sea lion vital rates. These studies have been conducted on both Steller sea lions and other pinniped species and are briefly reviewed below by toxic category.

Steller sea lions in many areas may have been directly exposed to crude and refined petroleum products due to the many small and some large or very large oil spills that have occurred throughout their range. Unlike the Exxon Valdez oil spill, after most smaller spills, and some large spills, there is very little study of ecological effects. However, large and very large spills (as defined by MMS in the 2003 Cook Inlet Oil and Gas lease Sale EIS 2003) have occurred in waters off of California (e.g., the Santa Barbara spill), the coast of Washington (e.g, the heavy fuel oil spill caused by the grounding of the U.S.S. General M.C. Meiggs), Prince William Sound (the Exxon Valdez oil spill), the Kodiak archipelago, and other locations in their range. A complete review of this topic is beyond the scope of this document. We consider this topic further in the section below on oil and gas development.

Sea lions exposed to oil spills may become contaminated with PAHs through inhalation, dermal contact and absorption, direct ingestion, or by ingestion of contaminated prey (Albers and Loughlin 2003). After the Exxon Valdez oil spill, Calkins *et al.* (1994) recovered 12 Steller sea lion carcasses from the beaches of Prince William Sound and collected 16 additional Steller sea lions from haul out sites in the vicinity of Prince William Sound, the Kenai coast, and the Barren Islands. The highest levels of PAHs were in animals found dead following the oil spill in PWS. Furthermore, sea lion bile samples collected seven months after the spill had levels of PAH metabolites consistent with exposure to PAH compounds (Calkins *et al.* 1994). Histological examinations found no lesions that could be attributed to hydrocarbon contamination and, hence, no evidence of damage due to oil toxicity (Calkins *et al.* 1994). However, this study was limited by a lack of pre-spill data on key health and other parameters that would have allowed more focused studies of sublethal effects. Further, as the decline in the western DPS was underway at the time of EVOS, researchers were not able to discriminate spill effects, and, hence, the kinds of detailed studies related to chronic effects that were conducted on some other species were not undertaken on sea lions.

OC contaminant exposure in marine mammals and other wildlife has been associated with reproductive failures (Helle *et al.* 1976, Reijnders 1986), population declines (Martineau *et al.* 1987), carcinomas (Martineau *et al.* 1999, Ylitalo *et al.* 2005), and immune suppression (de Swart *et al.* 1994, Ross *et al.* 1996; Beckmen *et al.* 2003). No toxicological studies have been published on Steller sea lions to determine possible effects of OC contaminants. However, OCs that cause health impacts in other species have been measured in subsets of Steller sea lion populations from Japan, the Russian far east, Aleutian Islands, Pribilof Islands, Gulf of Alaska and Southeast Alaska (Lee *et al.* 1996, Varanasi *et al.* 1992, Hoshino *et al.* 2006, Hong *et al.* 2005, Myers 2005). PCB congener levels in 4 out of 10 sea lions near Hokkaido and 2 out of 12 near Olyutorsky Bay (Kamchatka) (Hoshino *et al.* 2006) exceeded the levels in ribbon seals with decreased circulating thyroid hormones (Chiba *et al.* 2001). However, no sea lions in a study by Hoshino *et al.* (2006) exceeded the levels of PCBs in harbor seals that experienced immune suppression (de Swart *et al.* 1996). Furthermore, Steller sea lions may not have the same sensitivity to toxic PCBs as found for ribbon seals. Thus, the ultimate effect of PCB toxicity on sea lion fitness is unknown. Heintz *et al.* (2006) investigated OCs in a primary

Steller sea lion prey item (pollock) through much of the range of Steller sea lions in Alaska. They found higher concentrations of OCs in pollock in southeast Alaska, within the range of the eastern DPS, but also found OCs to be ubiquitous throughout their sampling area. Given that the eastern DPS has been increasing (e.g., recovering) while consuming prey with higher OC concentrations, OCs may not be the primary factor for recent declines in population and natality observed in the western DPS.

OC concentrations have been significantly different among Steller sea lions in some regions (Myers and Atkinson 2005, Hoshino *et al.* 2006), although not consistently so throughout all studies (Hong *et al.* 2005). Typically a few individuals with particularly high concentrations will skew the mean results, giving high standard deviations that result in non-significant or inconclusive statistical results. The studies that measured more than one OC generally found that the PCB congeners and DDT metabolites were the most prevalent OCs measured in Steller sea lions. No studies have been published that report any PBDE congeners, however this is likely to change in coming years.

Studies of the effects of known OCs have not been conducted on marine mammals in the U.S. However, studies from Europe have provided threshold levels of OCs above which immunosuppression or reproductive problems can be expected (de Swart *et al.* 1994, Ross *et al.* 1996). Although these studies were conducted on harbor seals, the thresholds are often used for related species such as Steller sea lions. Several individual California sea lions (*Zalophus californianus*) have been sampled that had high concentrations of DDTs and PDBs (Kannan *et al.* 2004), which were linked to physiological impairments (Debier *et al.* 2005) and cancer associated mortality (Ylitalo *et al.* 2005). Likewise, a threshold for reproductive failures (i.e., spontaneous abortions) has been estimated, based on a mass toxicity event of California sea lions from the 1970s (DeLong *et al.* 1973, Gilmartin *et al.* 1976). No recent samples from Steller sea lions have approached this threshold, indicating a mass mortality from an acute toxicity event was not likely the cause of the sea lion decline.

Although publications on the effects of emerging contaminants are few (Barron *et al.* 2003), one class of “emerging” environmental contaminants, the PBDEs, are quickly gaining the attention of regulatory agencies (de Wit *et al.* 2002). These compounds are added to plastics, textiles, clothing, electronic circuit boards and other materials as flame retardants. PBDEs are known to enter the environment through urban runoff and sewage outfalls and have been shown to bioaccumulate in marine animals (de Wit *et al.* 2002). A number of studies have shown that some PBDE congeners may induce toxicological effects in laboratory animals, including immune dysfunction, liver toxicity, thyroid disruption and possibly cancer (de Wit *et al.* 2002, MacDonald 2002). Some data are available on the levels of PBDEs in marine mammals from North America (Ikonomou *et al.* 2002, She *et al.* 2002, Stapleton *et al.* 2006). Another study reported that PBDEs have increased 10- to 100-fold in blubber of harbor seals collected near San Francisco Bay over the last decade (She *et al.* 2002). Because these compounds continue to be used in the U.S. and other regions of the world, the levels measured in marine environmental samples are expected to increase. Ikonomou *et al.* (2002) reported that PBDEs may become the most prevalent persistent organic pollutant in arctic ringed seals in the next 50 years. However, few studies have looked at PBDE exposure and associated health effects in marine mammals. Thus, the potential for Steller sea lion exposure to unknown contaminants, such as PBDEs, many of which are increasing, is a significant gap in our understanding of impacts of pollutants on Steller sea lions (Barron *et al.* 2003).

Heavy metals are also contaminants of concern. Heavy metal concentrations measured in Steller sea lion livers were generally much lower than in northern fur seals (Noda *et al.* 1995). For example, mercury levels in the hair of young Steller sea lions from both the western and eastern DPSs were lower than for northern fur seals (Beckmen *et al.* 2002), yet concerns remained about possible effects on fetal development and interactive effects with other contaminants. Castellini (1999) found that zinc, copper, and metallothionien (a chelating compound) levels were comparable between sea lion pups sampled from both the western and eastern DPSs, and were lower than for captive sea lions. Kim *et al.* (1996) reported on the accumulation of butyltin in the liver of Steller sea lions from Alaska and Japan and found much lower levels in the Alaska samples than in those from Japan. These authors also suggested that butyltin degrades rapidly in sea lions and does not bioaccumulate. Although these studies are not comprehensive, they indicate that heavy metals were not likely a significant factor in the decline of the Steller sea lions. Thus, low-level mercury exposure is evident in pups and females, but the long-term effect mercury or even methylmercury has on Steller sea lions is unclear (Beckmen et al. 2002). Based on recent data on methylmercury in salmon, Beckmen et al. (2002) suggest that exposure at low levels is cause for concern because methylmercury is a powerful neurotoxicant that acts synergistically with polychlorinated biphenyls. Studies on non-human primates have demonstrated both reproductive effects (Burbacher et al. 1984, Burbacher et al. 1988; Mohamed et al. 1987) at methylmercury levels that do not cause overt toxicity, as well as developmental effects due to exposure of relatively low levels of exposure in utero. Recent unpublished findings by Castellini et al. (2008) suggest that significant portion of very young pups in the western DPS have total mercury levels higher than those which the EPA suggests may indicate exposure sufficient to produce toxic effects. Such contaminant load in young pups should reflect load transferred from their mothers. Not enough is currently known about the potential effects of this or other contaminants on the recovery of Steller sea lions.

In summary, contaminant risks are largely unknown in Steller sea lions and are little understood in pinnipeds in general (Barron *et al.* 2003). Definitive studies that have causally linked contaminant exposures and adverse effects in pinnipeds have been limited to laboratory studies with PCBs and Hg in dietary studies with captive seals. Field studies with pinnipeds have been confounded with other factors and cannot be unambiguously linked to contaminant caused impacts. The sensitivity of pinnipeds to contaminants relative to the sensitivity of other species is largely unknown. Thus, adverse effect levels of contaminants in Steller sea lions must be inferred from studies in other species (Barron *et al.* 2003). As a result, the primary data gap is an understanding of what levels of contaminants affect sea lion health, and subsequently also affect vital rates, especially reproduction. Further, the possible effects on reproduction from chronic exposure to relatively low concentrations of toxic substances and the potential for reactive metabolites to cause damage to target tissues must be understood to be able to relate observed toxin levels to population effects in the western DPS of Steller sea lion.
Steller sea lions have shown various levels of toxic substances including heavy metals and organochlorines with generally higher levels in the most western portions of the range including Russia. In general, these concentrations of substances are not believed to have caused

high levels of mortality or reproductive failure. However, there are no studies on the effects of toxic substances on Steller sea lions specifically to determine their impact on vital rates and population trends. Chronic exposure to toxic substances may result in reactive metabolites that could cause damage to DNA, RNA, and cellular proteins. Sea lions exposed to oil spills may become contaminated with polycyclic aromatic hydrocarbons (PAHs) through inhalation, dermal contact and absorption, direct ingestion, or by ingestion of contaminated prey. Newer contaminants such as PBDEs have not been measured in Steller sea lions. Thus, overall, there is still some concern that toxic substances may have indirect impacts on individual vital rates, but that it is unlikely to be having substantial impacts on the population. Further study is needed to test the response of individual sea lions to these concentrations of toxins.

4.2.3 Impacts of Killer Whale Predation

4.2.3.1 Killer Whale Ecology

In the North Pacific Ocean three ecotypes of killer whales have been recognized by their genetics, morphology, acoustics, association patterns, and feeding ecology, including their prey (Bigg *et al.* 1987, Frost *et al.* 1992, Ford *et al.* 1998, Ford *et al.* 2000, Ford and Ellis 1999, Barrett-Lennard 2000, Hoelzel *et al.* 1998, Matkin *et al.* 2006). Differences in the movement patterns among killer whale ecotypes have led, in part, to their names; i.e., “resident”, “transient”, and “offshore.” Specifically, residents have the smallest home range and typically return each year to predictable locations, transients have larger home ranges and have less predictable movements as they transit through local areas quickly, and offshores have the largest home ranges that include areas farther offshore.

Resident killer whales are known to be fish-eaters, in contrast to transients that feed on marine mammals. For offshores, relatively few feeding observations are available, and the limited data indicate these whales appear to prey primarily on fishes, including sharks. However, until the diet of offshores is better understood, the possibility exists that offshores may kill other marine mammals, including Steller sea lions, at least in some regions or seasons. As the currently available information indicates that transient killer whales are the only ecotype that influences the abundance of sea lions, the remaining information on abundance, movements, and diet pertains primarily to transients.

Limited information is available to assess the population structure of transient killer whales within the range of the western DPS, and less information is available for Russian waters. Currently two stocks of transient killer whales have been recognized: (1) the AT1 stock, which occurs from Prince William Sound west through the Kenai Fjords, and (2) the Gulf of Alaska, Aleutian Islands, and Bering Sea (GOA/AI/BS) stock (2004 SAR’s). The abundance and stock structure of the AT1 stock have been well documented, and the abundance of this isolated population has declined from 22 whales in 1989 to only 8 whales in 2004 (Matkin *et al.* 1999, Angliss and Outlaw 2005). In contrast, relatively few data exist for the GOA/AI/BS transient stock, particularly for waters west of Kodiak Island.

Surveys conducted by NMFS in the western Gulf of Alaska, Aleutian Islands, and Bering Sea since 2001 have documented that all three ecotypes use these western Alaska waters.

Preliminary analyses of photo-id and genetic data from within the coastal survey area from Kenai Fjords to Tanaga Pass provide insights on possible movements of transient killer whales, and also suggest that there may be some finer scale population structuring of transients. Specifically, no movements of individual transients have been documented by photo-id between the central and eastern Aleutians (NMFS unpublished data), with a preliminary dividing line at Samalga Pass (170 degrees West longitude). Preliminary analysis of mtDNA sequences supports this inference, as different haplotypes have been sampled on either side of this possible structural boundary (NMFS unpublished data). However, both genetic and photographic sample sizes are low for the central Aleutians. Similarly, whales from the Gulf of Alaska and those from the Aleutian Islands do not generally appear to overlap in distribution, with a gap in distribution between the Shumagin Islands and Kodiak (NMFS unpublished data). However, there have been a small number of photographic matches of individual whales from the Unimak Pass area in the eastern Aleutians to the northeast side of Kodiak Island (NMFS and North Gulf Oceanic Society, unpublished data). Further samples and analyses are needed to assess the significance of these preliminary findings.

4.2.3.2 Abundance and Diet of Killer Whales

The abundance of transient killer whales has recently been estimated through (1) line transect surveys, which provide an estimate of the number of whales present, during the sampling period, in the region surveyed and (2) mark-recapture analyses based on whales identified through photo-id, which provide an estimate of the total number of individual killer whales in the region surveyed across the entire survey period. Analysis of line transect survey data collected between 2001 and 2003 indicate that the abundance of transients in the coastal waters between the Kenai Fjords in south-central Alaska and Tanaga Pass in the central Aleutians is approximately 251 whales (95% CI 97-644) during the summer months (Zerbini *et al.* 2006). The density of transients appears to vary regionally, with higher densities from the Shumagin Islands through the eastern Aleutians. However, the minimum count of transients in this area from the combined NMFS and North Gulf Oceanic Society (NGOS) photo-id catalogues is currently 314 whales (Angliss and Outlaw 2005), and preliminary mark-recapture estimates for transients based on photo-identification data are also higher than the line transect estimates (NMFS unpublished data). Current abundance estimates and photo-id cataloguing only refer to coastal waters within approximately 30 nm of the Aleutian Islands and adjacent coasts of southwestern Alaska. The abundance and population structure of transient killer whales in offshore areas in the Pacific and Bering Sea are still relatively unknown. Thus, the minimum number of transient killer whales in the U.S. portion of the western DPS is 314, and the estimated abundance will increase when analyses are completed and survey effort increases.

The diet of AT1 transients is relatively well understood. Based on more than 20 years of field observations, these whales are thought to feed primarily on harbor seals and Dall's porpoise (Saulitis *et al.* 2000, Heise *et al.* 2003, Maniscalco *et al. in press*). The feeding habits of GOA/AI/BS transients are less well known in general and essentially unknown during the period from fall to spring (Maniscalco *et al. in press*). Stomach contents of two stranded carcasses contained a harbor seal, Dall's porpoise, and Steller sea lion remains (Heise *et al.* 2003). Observations of feeding by GOA/AI/BS transients have been limited to date, but observed prey include fur seals, gray whales, minke whales, and Steller sea lions (Maniscalco *et al. in press*, NMFS unpublished data). The analysis by Herman *et al.* (2005) of blubber biopsy samples from eastern North Pacific killer whales indicate that profiles for fatty acids, carbon and nitrogen stable isotopes, and organochlorine contaminants were consistent with previously reported dietary preferences; i.e., fish for resident whales and marine mammals for transients. Regional stable isotope ratios varied considerably, indicating prey preferences may be region-specific, in addition to ecotype-specific. Thus, some groups of GOA/AI/BS transients may specialize on certain prey species, including sea lions (Matkin *et al.* 2005), as AT1 transients specialize on harbor seals and Dall's porpoise. The measured stable isotope values, which reflected diet for the mid-April through mid-July period, for all three killer whale ecotypes were consistent with published dietary preferences based on visual observations. For example, measured stable isotope values for AT1 transients were very similar to modeled stable isotope values, which were based on visual observations (i.e., primarily harbor seals (56%), Dall's porpoises (38%) and harbor porpoises (6%); Herman *et al.* 2005). Measured stable isotope values for GOA, AI, and BS transients indicated the primary prey items were dominated by animals at lower trophic levels than Steller sea lions and harbor seals (Herman *et al.* 2005). Preliminary analysis of blubber samples taken from GOA transients indicates isotope levels similar to local sea lions (NMFS unpublished data[13]).

Matkin *et al.* (2005) studied killer whales in southeast Alaska and in the Kenai Fjords area from 2002 to 2004. They identified 23 transients, of which 13 were Gulf of Alaska transients (GAT). This was in sharp contrast to their results from southeast Alaska where they identified 100 transients in an area approximately equal in size; indicating about four times the density of transients in southeast Alaska (Matkin *et al.* 2005). Despite the higher density of transients, the southeast Alaska population has been increasing overall (with some rookeries showing stability), and likely has been increasing for many years under similar numbers of killer whales. Adult female Steller sea lions seem unaffected by killer whale predation at Chiswell Island although their pups suffered substantial losses over the time period observed by Matkin *et al.* (2005).

In a follow-up paper, Maniscalco *et al.* (2007) describe their observations of GOA transient killer whale[14] predation in the Kenai Fjords area from 2000 to 2005. In many ways this paper represents an evolution of their thinking and an attempt to compare field estimates of predation rates to the model predictions described in Williams *et al.* (2004). Maniscalco *et al.* (2007) observed 9 predation events and an additional 16 which were inferred from remote video monitoring; all were sea lions. Based on their observations they estimated that 59 sea lions were consumed over the summer seasons of 2002-2005. However, based on estimates of killer whale caloric requirements (Williams *et al.*2004), they would have expected loss due to orca predation of 103 sea lions over this period. Maniscalco *et al*. (2007) found that unlike killer whales from other regions, GOA transients in the Kenai Fjords rested about 43% of the time.

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[13] There have been two samples taken from GOA transients (e.g., the "kodiak killers") that have been analyzed (collected by Craig Matkin). These samples contained nitrogen isotope values of ~18. Steller sea lions in the GOA have nitrogen isotope values of around 17.5-18.0 themselves (but a low sample size). If killer whales were eating only Steller sea lions, they should have nitrogen isotope values up around 20.0-20.5, which they do not. Limited sample sizes, but the data available do not support the idea that all GOA transients eat sea lions exclusively.
[14] The current population estimate for GOA transients is 93 (Angliss and Outlaw 2005).

They propose this may be a strategy to conserve energy. Therefore, estimates of caloric demand from Williams *et al.* (2004) may be too high.

It has also been proposed that GOA transients may target pups at rookeries during the summer, potentially having a dramatic effect on survival. Maniscalco *et al.* (*in press*) observed predation of pups at Chiswell Island either by single adult killer whales (one whale in particular) and when adults were teaching calves how to hunt. In British Columbia, a similar study positively correlated transient killer whale group size to pinniped prey size (Ford *et al.* 1998). Preying on pups may be a common strategy for lone, sick, or old transient killer whales (Maniscalco *et al. in press*, Vos *et al.* 2006, Heise *et al.* 2003).

4.2.3.3 Hypotheses and Modeling Attempts

To explore the potential impact of killer whale predation on Steller sea lions, Barrett-Lennard *et al.* (1995) constructed a simulation model. A range of values for transient killer whale abundance, killer whale energy requirements, and killer whale prey selection parameters was explored because of the substantial uncertainty in the current empirical data for these parameters. Steller sea lion parameters in the model include initial population abundance, sex and age distributions, age specific vulnerability to predation, and a density dependent growth rate. The model assumes an unknown 'baseline' level of sea lion mortality due to killer whale predation in a stable sea lion population. Simulations examine changes in sea lion abundance, due to mortality completely additive to baseline mortality, from an increase in either killer whale abundance or the percentage of sea lions in the diet of killer whales. Based on parameter values consistent with current empirical data from the range of the western DPS of sea lions, simulation results suggest that: 1) killer whale predation did not initiate the decline of the sea lion population; 2) killer whale predation could cause a continued decline in sea lion numbers in western Alaska based on the estimated abundance of sea lions in 2000; and 3) killer whale predation is not likely to drive the sea lion population to extinction (Barrett-Lennard *et al.* 1995). Further, when the abundance of sea lions declined to 100,000 to 150,000, the additional mortality (above baseline mortality) from killer whale predation could have been sufficient to drive the decline. Sensitivity analyses indicate changes in sea lion abundance were influenced primarily, and equally, by the number of transient killer whales and the proportion of their diet provided by sea lions, followed by sea lion age-specific vulnerability to predation. When the estimated abundance of sea lions and killer whales in the range of the eastern DPS is used with the parameter combinations that cause a moderate impact on the western DPS of sea lions, the model predicts that killer whale predation would result in a fairly rapid decline of eastern DPS sea lions which, as noted earlier, has not been the case.

A comparative bioenergetics and demographic model was used by Williams *et al.* (2004) to assess the potential impacts of killer whales on Steller sea lion populations in the Aleutian Islands. Four types of energetic information were measured or estimated: 1) the caloric needs of individual killer whales, taking into account differences in body mass and reproductive status; 2) the caloric value of individual prey including adult sea lions and pups; 3) the digestive efficiency of killer whales, which determined the ability of the animal to utilize energy in prey tissue; and 4) the likely or possible prey preferences of individual killer whales. This information on individual bioenergetics was then compared to population-level estimates of the number of killer whales (NMFS unpublished data), the abundance of sea lions before and during the decline (see Chapter 3), and the demographic rates governing the sea lion population (York 1994). The population-wide losses to predation needed to generate the observed changes in the Steller sea lion population, if all losses occurred from predation, were then estimated. From these data, Williams *et al.* (2004) reported that an average adult killer whale would require 2 - 3 sea lion pups per day or approximately 840 pups per year when feeding exclusively on young Steller sea lions. In comparison, only one third to one half of an adult female sea lion per day (approximately 160 per year) would be needed to satisfy the killer whale's metabolic needs. Nearly 1,200 Steller sea lions would be eaten per year to meet the caloric requirements of one killer whale pod consisting of 5 individuals, assuming 16% pups and 84% juvenile and adult sea lions consumed, based on the life table for sea lions (York 1994). The annual number of sea lions eaten increases to 39,644 for an estimated population of 170 transient killer whales, approximately three times the highest annual removal rate needed to drive the observed sea lion declines in the 1980s. Despite the conservative estimates of energetic needs and the abundance of transient killer whales, the model calculations demonstrated that relatively minor changes in killer whale feeding habits could account for the decline of Steller sea lion populations observed for the Aleutian Islands. The caloric demands of as few as 27 male or 40 female killer whales (minimally 23% of transients) could account for the estimated 10,885-11,575 sea lions lost per year at the height of the decline. Furthermore, predation losses to a single pod of five killer whales could theoretically prevent the present Steller sea lion population from recovering.

Examining the potential impact of killer whale predation on Steller sea lions on a broad ecosystem basis, Springer *et al.* (2003) presented a hypothesis that predation was paramount among top-down forces contributing to the sea lion decline. Their "Sequential Megafaunal Collapse" hypothesis is based on the premise that post-World War II industrial whaling depleted large whale populations in the North Pacific, depriving killer whales of an important prey resource. Killer whales thus began feeding more intensively on smaller marine mammals, and this predation resulted in the sequential decline of harbor seals, northern fur seals, Steller sea lions, and northern sea otters in the northern North Pacific Ocean and southern Bering Sea. Due to the acknowledged lack of direct evidence that killer whale predation drove the pinniped declines, Springer *et al.* (2003) explain the declines based on a logical interpretation of known patterns and feasibility analyses of the hypothesized causal process. They suggest current predator prey dynamics are unlikely to provide evidence for the sequential pinniped declines, because prey populations are relatively smaller and comparatively stable, and the abundance of killer whales also may be much reduced.

The Sequential Megafaunal Collapse hypothesis has generated considerable interest and debate concerning the role of killer whale predation in the ecosystem dynamics of the North Pacific. Several studies have examined the hypothesis and conclusions from those studies have varied:

> DeMaster *et al.* (2006) concluded that the available data do not support the assumption that some species of large whales were important prey for killer whales, and the available qualitative data indicate that although the biomass of some large whale species likely declined in abundance, those declines were offset by increasing abundances of other large whale species in the 1960s and 1970s. Further, DeMaster *et al.* concluded

that statistical tests do not support the assumption that the pinniped declines were sequential.

Mizroch and Rice (2006) show that there was actually a several year lag between the decline in whale catches and the start of the decline of pinnipeds. Because of the extraordinary whale biomass removals in the mid-1960s, any whaling-related prey shifting should have started by 1968, not the mid-1970s as suggested by Springer *et al.* (2003). Mizroch and Rice (2006) also examined data on the contents of killer whale stomachs, and observational records of killer whale interactions with large whales, and refute the Springer *et al.* (2003) assumption that North Pacific killer whales depended on large whales as prey either prior to or concurrent with the whaling era.

Trites *et al.* (2006c) showed that populations of seals, sea lions and sea otters increased in British Columbia following commercial whaling, unlike the declines noted in the Gulf of Alaska and Aleutian Islands. They argue that a more likely explanation than the Springer *et al.* (2003) hypothesis for the seal and sea lion declines and other ecosystem changes in Alaska stems from a major oceanic regime shift that occurred in 1977. They additionally note that killer whales are unquestionably a significant predator of seals, sea lions and sea otters — but not because of commercial whaling.

Wade *et al.* (2007) argued that available data do not support the Springer *et al.* (2003) hypothesis. They noted spatial and temporal patterns of pinniped and sea otter population trends are more complex than Springer *et al.* (2003) suggest, and often inconsistent with their hypothesis. Populations remained stable or increased in many areas, despite extensive historical whaling and high killer whale abundance. Populations remained stable or increased in many areas, despite extensive historical whaling and high killer whale abundance. Furthermore, observed killer whale predation has largely involved pinnipeds and small cetaceans; there is little evidence that large whales were ever a major prey item in high latitudes. They summarized that: a) large whale biomass in the Bering Sea did not decline as much as suggested by Springer *et al.* (2003); b) much of the reduction occurred 50-100 years ago, well before the declines of pinnipeds and sea otters began; and c) thus the need to switch prey starting in the 1970s is doubtful. They compiled data showing that, with the sole exception that the documented sea otter decline followed the decline of pinnipeds, the reported declines were not in fact sequential. Given this, Wade et al. (2007) concluded that it is unlikely that a sequential megafaunal collapse from whales to sea otters occurred.

Kenney (2007:515), in a review of the collection of papers in Estes *et al*. (2006) summarized that "…recently published papers…have pointed out several weaknesses in the [Sequential Megafaunal Collapse] hypothesis, such as the finding that killer whales are not important predators of great whales, with the exception of gray whale calves and minke whales; that there is a mismatch in the timing of the major pulse of whaling in the northern North Pacific and the observed declines in pinnipeds and sea otters; and that there have not been similar declines in Dall's porpoise and other small cetaceans that are known to be killer whale prey."

4.2.3.4 Direct Impact of Killer Whales on Steller Sea Lions

Historical accounts of killer whale predation on marine mammals in the northern North Pacific, though somewhat limited in number, are roughly consistent with recent observations that killer whales prey on a variety of species of marine mammals, particularly pinnipeds and small cetaceans (Mizroch and Rice 2006, Wade *et al. in 2007*), with specialization likely in GOA transient killer whales (Maniscalco *et al.* 2007). The estimated abundance of mammal-eating killer whales throughout most of the range of the western DPS of Steller sea lion (Kenai Peninsula to Tanaga Pass in the central Aleutian Islands) is 251 (95% C.I. 97-644) (Zerbini *et al.* 2006) for the years 2001-03. Mammal-eating killer whales were found to be more abundant from the Shumagin Islands to the west (226) than they were east of the Shumagins through Kenai Peninsula (27). Mammal-eating killer whales were found to be at their highest density in summer in the eastern Aleutian Islands, stretching from Umnak Island to the west to the Shumagin Islands to the east. Angliss and Outlaw (2005) estimate the number of GOA transient killer whales at approximately 93 individuals. Maniscalco *et al.* (2007) estimated a minimum of 19 and maximum of 39 GOA transients in their Kenai Fjords area study. Matkin *et al.* (2005) found nearly 4 times that number of transient killer whales (100 transients) in a similar area in southeast Alaska.

Williams *et al.* (2004) hypothesized that a population of 170 mammal-eating killer whales could have caused the decline of Steller sea lions. Their critical assumption was that the killer whales would have preyed exclusively on sea lions. Subsequent studies have tested this assumption, and do not suggest that mammal-eating killer whales prey exclusively on Steller sea lions. Wade *et al.* (accepted) reviewed observations of killer whale predation on marine mammals since the 1960s. The percent of kills by mammal-eating killer whales that were Steller sea lions was 6% in the BSAI, and 22% in the GOA, with most of those observations from the summer. Since 2001, observations by NMML/NOAA of sea lion kills in summer were 11% in the BSAI. Matkin *et al.* (*in press*) report 4% in spring/summer in the BSAI. Estimates for the BSAI therefore range from 4% to 11%. Analysis of contaminant concentrations and fatty acids confirms that, as suspected, mammal-eating killer whales have a chemical signal in the blubber that is entirely consistent with an exclusive diet on marine mammals (Herman *et al.* 2005, Krahn *et al. in review*). Analysis of stable isotope concentrations in mammal-eating killer whale skin from the BSAI results in values that are in close agreement with values predicted from observations of predation of ~4 to 11% Steller sea lions (Krahn *et al. in review,* NMFS unpublished data), suggesting the visual observations do provide an accurate assessment of killer whale predation during that time of year.

It is important to consider the effects of killer whale predation in terms of sea lion natural mortality rates within the western DPS. For a stable population of Steller sea lions in the western DPS in Alaska, the average annual natural mortality rate is about 20% – this reflects about 10,000 animals dying each year due to trampling, senescence, disease, killer whales, etc. This important fact is often overlooked, and killer whale predation is merely added on top of this background natural mortality rate (e.g., Barrett-Lennard *et al.* 1995). Maniscalco *et al.* (in press), estimated the average predation by killer whales in Kenai Fjords accounted for 3% (their field metabolic estimates) to 7% (based on Williams *et al.* 2004 estimates) of the local summer seasonal population of sea lions each year. Maniscalco *et al.* (in press), conclude that although these killer whales were observed to eat sea lions exclusively (in their limited study area and time), killer whale predation accounted for only about a quarter of the annual natural mortality and is probably not hindering recovery.

If it is assumed that Steller sea lions (and other pinnipeds) have always been prey of mammal-eating killer whales, then killer whale predation would be a component of that natural mortality. The current percentages of killer whale predation calculated above are lower than the 20% natural mortality rate. This indicates that this level of predation could have been a component of natural mortality, and therefore not responsible for the decline of the western stock of Steller sea lions. Additionally, if the population of killer whales is assumed to have been the same size historically as it is now, that level of predation would represent a smaller fraction of the sea lion population before its decline, and thus less of natural mortality.

Finally, life-history changes in the western stock of Steller sea lions through time argue against the hypothesis that killer whale predation alone was responsible for the decline. Density-dependent responses seen in the western Steller sea lion population were lower growth and pregnancy rates in the 1980s than the 1970s (Calkins *et al.* 1998, Pitcher *et al.* 1998). This indicates carrying capacity for sea lions likely declined over this period. This apparently continued through the 1990s as evidenced by a possible decline in natality (Holmes and York 2003). These shifts in life history parameters during the declines argue against killer whale predation as a main cause of the decline, as, for example, there is no direct reason why increased killer whale predation would lead to a decline in natality. In addition, the eastern DPS has increased at approximately 3% per year for at least 20 years while co-existing with a similar population of transient killer whales in an environment historically exposed to commercial whaling and environmental change.

4.2.3 Inter-Specific Competition for Prey Resources

Piscivorous fish consume many of the same species and sizes of prey as Steller sea lions. The strength of these food-web interactions has likely changed during the past 30 years in response to both natural and anthropogenic factors. For instance, annual differences in the size and distribution of young-of-the-year as well as adult pollock affect annual levels of cannibalism (Livingston 1991, Wespestad et al. 2000). Differential rates of fishing within the groundfish community may have also indirectly contributed to increased in arrowtooth flounder populations, a species with considerable diet overlap with Steller sea lions (NMFS 2000, 2001). How these changes as well as substantial increases in the population of Pacific halibut since the 1980s (Hollowed et al. 2000, IPHC 2000, Wilderbuer and Sample 2000, Trites et al. 1999) affect the prey field and foraging patterns of Steller sea lions or relate to population level impacts remain to be determined.

The diets and distribution of many marine mammals and birds also overlap those of the western DPS of Steller sea lions. As consumers of common prey resources, the dynamics and concomitant prey biomass removed by these sympatric piscivore populations may therefore affect the quantity and quality of prey available to Steller sea lions. As such, recovery of Steller sea lions may be affected by changes in the abundance, distribution, and prey removal by other apex predators. Whales are considered significant consumers in many marine systems and models estimate that prey consumption (in terms of biomass) by cetaceans approaches or exceeds removals by commercial fisheries (Laws 1977, Laevastu and Larkins 1981, Bax 1991, Markussen *et al.* 1992, Kenney *et al.* 1997, Trites *et al.* 1997, Witteveen *et al.* 2006). Such high levels of consumption can have significant effects on the distribution and abundance of prey species and the structure of marine communities (Perez and McAlister 1993, Kenney *et al.* 1997). Likewise, removals and recovery of cetacean populations may affect marine ecosystems through complex trophic cascades (Laws 1985, NRC 1996, Merrick 1997, Trites *et al.* 1997, Springer *et al.* 2003, Witteveen *et al.* 2006). Shore-based and pelagic whaling in the 1900's significantly reduced the number of large whales in the North Pacific, reducing their consumption (biomass removal) of certain fish, cephalopods, and zooplankton within marine ecosystems (Rice 1978) and effectively increasing prey available to other consumers in the system (Springer *et al.* 2006). Following decades of international protection, the abundance of some whale stocks has increased, including a substantial increase in central North Pacific humpbacks between the early 1980s and early 1990s (Baker and Herman 1987, Calambokidis *et al.* 1997), and late 1990s (Calambokidis and Barlow 2004). It has been hypothesized that whale stock resurgence may have reduced prey availability and contributed to declines of piscivorous pinnipeds and birds in the Gulf of Alaska and Bering Sea ecosystems (Merrick 1995, 1997, NRC 1996, Trites *et al.* 1999).

Several large piscivorous whales are migratory and fulfill their annual consumption needs on high latitude feeding ground, including waters found within critical habitat of the western DPS of Steller sea lion. Substantial seasonal feeding aggregations of humpback (Waite *et al.* 1998, Witteveen 2003), fin, and minke whales occur within the Gulf of Alaska and Bering Sea. Their diets include large zooplankton species and a variety of schooling fish (Thompson 1947, Nemoto 1957, Moore *et al.* 2000, Tamura and Ohsumi 2000) that are also consumed by Steller sea lions (capelin, herring, sandlance, smelts, small pollock) (Pitcher 1981, Sinclair and Zeppelin 2002) or by the prey of sea lions (pollock, cod, arrowtooth flounder) (Livingston 1993). As such, piscivorous whales have the potential to compete with Steller sea lions both directly when feeding on common prey and indirectly when consuming zooplankton and forage fish upon which other sea lion prey species feed. As populations of piscivorous cetaceans recover, this potential would be expected to increase.

4.2.4 Status of Important Steller Sea Lion Prey Resources in the Action Area

4.2.4.1 Walleye Pollock

Recruitment

Walleye pollock, *Theragra chalcogramma*, is a marine fish species that is highly fecund, producing millions of eggs per individual spawner, and which has highly variable mortality rates in early life (Bailey and Ciannelli, 2007). A consequence of this reproductive strategy (producing lots of young with high expected mortality) is fluctuating annual recruitment levels (the number of young fish entering the population each year). The instability of fluctuating year classes must be buffered by the averaging effect of many age classes in the population. Because most of the oldest fishes have been removed from the population by the fishery, the abundance of walleye pollock in the Gulf of Alaska is driven by recruitment. Although the recruitment process of walleye pollock in the Gulf of Alaska is one of the better studied systems in the world, admittedly there is still much that is not well-understood.

Pollock is an opportunistic species that has a broad range and has adapted to different environments. On the other hand, the population is limited by finding and adapting to local conditions that favor successful spawning (maximizing reproduction) and survival (minimizing mortality) of the early life stages. Local populations of pollock respond differently to shifting environmental regimes, as warming periods have seen those stocks at the southern margins of the pollock distribution falter or fail (Bailey et al. 1999). In the center of its distribution of mass in the eastern Bering Sea, pollock have been (if at all) favorably impacted by periods of environmental warming (Hollowed et al. 2001; Quinn and Niebauer 1995). Delayed springtime blooms may be a factor negatively influencing recruitment in the Bering Sea (Mueter et al. 2006). However, another recent study correlates cool temperatures in the Bering with increasing recruitment (Megrey, pers. comm.). In the Gulf of Alaska the situation appears more complex, as pollock have been initially favored by a warm environmental regime (e.g., stock increase in the late 1970s and mid 1980s) but negatively impacted afterwards (Hollowed et al. 2001), possibly in association with an increase of predator biomass. However, conflicting with other findings, a recent study has tentatively and weakly linked cool springtime SST with increasing recruitment (Hollowed, pers. comm.). These conflicting findings illustrate the difficulty in relating environmental indices near the birth of the cohort to highly variable recruitment 3-4 years later.

Pollock spawn once per year, in an event that involves individual pairing and courtship (Baird and Olla 1991), and that is highly concentrated in space and time (Kendall and Picquelle 1990). Given the fragility of eggs and larvae to environmental conditions, and their concentration in space and time, the survival of a whole year class is vulnerable to the vagaries of the ocean and weather, such as storms passing through Shelikof Strait, the major spawning site. On the other hand, pollock dynamics are buffered partly by multiple spawning stocks, spawning in different locales, compensatory mortality and by multiple age groups in the population. Spawning in different locations moderates the effects of temporal variation in habitat suitability by taking advantage of spatial variation. While the long life span of pollock is an adaptation that tempers the high variation in year class strength, a high abundance of predators on adults, as well as commercial fishing that removes older age groups, reduces the age-span over which mean abundance is averaged (and perhaps other aspects of the contribution of older fish to the population's viability). Consequently, the population will be more dependent on fewer age groups, hence contributing to overall stock variability (Longhurst 2002).

The spawning regions of pollock are noted for mixing of coastal and nutrient-laden oceanic waters and stratification of the water column, leading to enhanced productivity; these conditions favor the survival of early life stages of pollock. In the Gulf of Alaska pollock typically spawn during the last week in March and first week in April, in the Shelikof Strait (Ciannelli et al. 2007). In this area, mixing of the Alaska Coastal Current, the Alaska Stream and coastal water, along with springtime increases in sunlight and water column stratification leads to an intense spring bloom and reproduction of zooplankton. Zooplankton prey of pollock larvae are further concentrated by physical features, such as eddies and fronts (Napp et al. 1996), leading to favorable feeding conditions. Late larvae and juvenile pollock are advected toward favorable nursery areas, such as the waters around the Shumagin Islands.

Mortality rates of pollock eggs and young larvae are very high, ranging from 4% to 40% per day, but decline as the larvae develop. In fact, larval condition can vary from year to year and by location and high percentages of larvae in the ocean have sometimes been observed in poor feeding condition (Theilacker et al. 1996). Studies have shown that egg and early larval development and survival are suboptimal at temperatures below about 0^{o} and above 10^{o}-13^{o}C (Hamai et al. 1971; Nakatani and Maeda 1984; Blood 2002). Extremely high and low temperatures can be lethal to eggs and larvae, but generally for the Gulf of Alaska population, which is in the central part of its distribution (4^{o}-6^{o}C springtime SST), higher temperatures tend to favor better survival of early stages, perhaps through one or more indirect mechanisms (Bailey 2000). Optimal prey levels for successful feeding depend on many different conditions, including larval size, temperature, light levels, turbidity and turbulence (Porter et al. 2005), but generally they range between 20 and 40 prey/liter (Theilacker et al. 1996). At high levels of abundance, pollock may deplete their prey (Duffy-Anderson et al. 2002) leading to slower growth and higher mortality. At later stages, predation on juveniles is an important source of loss to the population. Piscivorous fishes, including halibut, cod, arrowtooth flounder and flathead sole contribute significantly to mortality of juvenile pollock (Livingston 1993).

An evolving perspective of the recruitment of pollock is that it is a complex process, influenced by both high frequency changes in the environment of young fish stages and by bounding effects of low frequency changes in the ecosystem (Bailey et al. 2005). As a consequence recruitment is caught in the push-pull between these scales. Larval mortality is highly variable and subject to many interacting high frequency factors (such as storms and prey availability), with feedback and non-linearity (Bailey et al. 2004). Larvae show sophisticated behaviors involving choice and decisions when confronted with multiple and perhaps conflicting stimuli (Olla et al. 1996). For example, they avoid turbulence by descending (Davis 2001), taking them out of the photic zone and into colder water where growth is less optimal and prey are less abundant (Kendall et al. 1994). Under normal circumstances, these conditions are associated with poor feeding and high mortality. However, prey is also driven deeper by turbulence and if there is bright daylight, these conditions are then optimal for feeding (Porter et al. 2005). Thus, environmental factors driving recruitment are governed by complex relationships. On the other hand, although juveniles also show complicated behaviors in response to the environment (e.g. Sogard and Olla 1996), they are less impacted by small-scale physics, and juvenile mortality seems to be more stable and predictable, occurring largely as a result of predation and density-dependent mechanisms. The role of density-dependent mechanisms also seems to be influenced by environmental factors (Ciannelli et al. 2004). Environmental and ecosystem structure shifts may also have indirect effects on pollock survival, such as causing changes in the operation of density-dependent mechanisms. For example, Ciannelli et al. (2004) found that the level of density-dependent mortality in juvenile pollock increases when water temperature and predation intensity are high. The build-up of predators in the community represents a low frequency, slowly changing pattern with lagged effects. Changes in ecosystem structure may be related to the relative stage in life history when recruitment is determined (i.e., larval versus juvenile control) (Bailey 2000). Therefore, control points may change from year to year, and depend on longer term changes in the environment and community structure, such as those occurring with environmental and biological regime shifts. General patterns in recruitment have been well-described by models incorporating stochastic mortality related to environmental conditions during the larval period and by deterministic factors and constraints during the juvenile period (Ciannelli et al. 2004; Ciannelli et al. 2005). It should be noted that although we have a fairly good understanding of how small-scale factors affect survival of early life stages, knowing how these factors combine and interact over larger and longer space and time scales (scale up), thus determining how pollock populations respond to the environment, fluctuating and shifting prey and predator abundances, and to self-regulation is a difficult problem.

ABC as Recommended in the Most Recent Stock Assessments

EBS pollock fell into Tier 1 of the ABC/OFL definitions for 2007, because reliable point estimates of biomass (B), B_{MSY}, and a reliable pdf of F_{MSY} are available through the age-structured stock assessment model (Ianelli et al. 2007). The year 2008 spawning biomass is estimated to be 1,380 thousand tons (at the time of spawning, assuming the stock is fished at Tier 1b level). This is below the *Bmsy* value of 11,876. Under Amendment 56, this stock therefore qualifies under Tier 1b and the harmonic mean value of the pdf of F_{MSY} is considered a risk-averse policy since reliable estimates are available. The exploitation-rate type value that corresponds to the *Fmsy* level was applied to the “fishable” biomass for computing ABC levels. The 2008 estimate of female spawning biomass (at time of spawning assuming 2008 Tier 1b catch levels of 1.17 million t) is 11,380 thousand t. This is below the *B40%* and *Bmsy* values (12,627 and 11,876 t, respectively) (Ianelli et al. 2007). The OFL’s and maximum permissible ABC values for Tier 1b are thus:

Tier	Year	Max ABC	OFL
1b	2008	11,170 thousand t	1,443 thousand t
1b	2009	1976 thousand t	11,204 thousand t

Given the rapidly declining stock and the recent increases in harvest rates, the assessment authors argued that it would be prudent to consider harvest levels that would 1) provide stability to the fishery; 2) provide added conservation to an important prey species of the endangered stock of Steller sea lions; and 3) provide extra precaution due to uncertain stock removals in Russian waters. The authors conceded that the degree to which the ABC should be adjusted downwards is difficult to quantitatively justify. The maximum permissible ABC under Tier 1b appeared too high to the stock assessment authors given the continued decline and the lower abundances of older fish seen in the population in recent years. For stability in catches and an added level of precaution given the uncertainty in recent recruitment trends, the authors recommended an ABC of 1.0 million t in 2008 for the BS pollock stock.

GOA pollock fell into Tier 3 of the ABC/OFL definitions, which require reliable estimates of biomass, $B_{40\%}$, $F_{30\%}$, and $F_{40\%}$. Under the definitions and current stock conditions, the overfishing rate is the fishing mortality rate that reduces the spawner stock biomass to 35 percent of its unfished level (the $F_{35\%}$ rate). The model estimate of spawning biomass in 2008 is 145,101 t, which is 26% of unfished spawning biomass (assuming average post-1977 recruitment) and below *B40%* (221,000 t), thereby placing Gulf of Alaska pollock in sub-tier "b" of Tier 3. The author's 2008 ABC recommendation for pollock in the Gulf of Alaska west of 140° W lon. (W/C/WYK) is 53,590 t, a decrease of 16% from the 2007 ABC, but close to the projected catch in 2007. This recommendation is based on a more conservative alternative to the maximum permissible *FABC* introduced in the 2001 SAFE. The OFL in 2008 is 72,110 t. In 2009, the recommended ABC and OFL are 71,580 t and 95,940 t, respectively.

AI pollock also fell into Tier 3 of the ABC/OFL definitions. The projected year 2008 female spawning biomass (*SB08*) is estimated to be 82,250 t, above the *B40%* value of 51,450 t, thus placing AI pollock in Tier 3a. The projected total age 3+ biomass for 2008 is 197,280 t. The maximum permissible 2008 ABC based on F*40%* = 0.196 is 28,160 t and OFL based on F*35%* = 0.244 is 34,040 t.

4.2.4.2 Pacific Cod

Recruitment
Pacific cod (*Gadus macrocephalus*) are demersal gadids that commonly occur in the Gulf of Alaska, Bering Sea, and Aleutian Islands. Little is known about the recruitment process in this species, though events occurring during the egg, larval, and juvenile stages of fish life history are thought to be major regulators of recruitment to the adult populations. Interannual recruitment variability is high in this species, due in part, to the high natality of females (hundreds of thousands to millions of eggs per female), high rates of cumulative mortality among early life history stages, and considerable interannual variation in growth rates.

Pacific cod spawn primarily February – June, and eggs are demersal and weakly adhesive. Larvae hatch out at approximately 3-4 mm SL and are pelagic, occurring at approximately 50 m (Rugen and Matarese 1988). Larvae are most abundant in the pelagic environment April-June (Matarese *et al.* 2003). Laboratory studies have shown that Pacific cod larvae hatch out from eggs between 16-28 days post fertilization, with peak hatching on day 21 (A.A. Abookire unpublished data). Laboratory studies on the development of external morphology and digestive function of Pacific cod larvae indicate that an ecological turning point may occur at approximately 9 mm TL (Yoseda *et al.* 1993). This developmental state was associated with significant changes in feeding morphology and also high mortality in that study. It should be noted that flexion in this species begins at approximately that time (10-15 mm SL), suggesting that improvements in swimming ability may have ecological consequences.

Climate-induced trophic restructuring is well-documented for a variety of species and marine systems (see Duffy-Anderson *et al.* 2005), and it is likely that recruitment in Pacific cod is similarly influenced. Alterations in climate influence ecosystem biota through a variety of co-occurring and synergistic processes (climate, seasonal timings and couplings, predation, feeding, transport), but of the one major factors is likely bottom-up forcing. Factors that affect hydrography influence zooplankton availability and ultimately fish abundance, though the explicit mechanism is as yet unresolved. Pacific cod larvae are opportunistic feeders that primarily consume copepod nauplii and copepodites (Takatsu *et al.* 2002), and consequently depend on zooplankton availability for growth and survival. Since Pacific cod larvae rely on a supply of zooplankton prey for food, climate-induced variations in ocean circulation that modulate the supply of zooplankton available could significantly impact feeding, growth, and survival in this species. Oceanographic features that act to concentrate zooplankton and larvae together, such as eddies and fronts, may enhance feeding opportunities for Pacific cod larvae. Factors that break down prey-larval associations, such as storms, mixing, and significant turbulence could lead to increased mortality among larvae.

Geographical variations in larval size are also likely related to interannual variations in local meteorological oceanographic conditions. Pacific cod larvae may be vulnerable to density-dependent regulation in the late-larval stage due to prey limitation and associated slow growth. Work with Atlantic cod (*Gadus morhua*), has shown that rapid growth increases survivorship, and that selection for fast growth is enhanced in slow-growing cohorts (Meekan and Fortier 1996). Variations in larval density may also contribute to differences in year-class strength in this species (Duffy-Anderson *et al.* 2002), though the affects of this form of pre-recruitment mortality may be comparatively small relative to other forcing factors.

As early juveniles, Pacific cod move toward the bottom and become demersal. Nursery habitats for juvenile Pacific cod are the shallow Alaskan coastal waters, where Pacific cod occur in highest abundances at moderate depths (15-20 m) (Abookire *et al.* in review). Juvenile Pacific cod appear to have fairly specific habitat requirements, and they may have an affinity for structure. Juvenile cod have been shown to be associated with eelgrasses (Laur and Haldorson 1996), sea cucumber mounds (Abookire *et al.* in review), and macroalgae. Consequently, Pacific cod may be sensitive to small-scale variations in spatial heterogeneities, and density-dependent recruitment in Pacific cod between age-0 and age-1 could be influenced by the availability and/or extent of nursery habitat (Fraser *et al.* 1996).

Juvenile cod diets in the Gulf of Alaska consist of small calanoid copepods, larval barnacles and crabs, mysids, worms, and gammarid amphipods, which suggest that Pacific cod feed on benthic and epibenthic as well as pelagic prey (Abookire *et al.* 2007). Juvenile cod demonstrate shifts in habitat preference with length, which may be related to changes in either foraging opportunity or predation vulnerability. Regardless, variations in growth and or survival associated with differences in habitat use could affect overall recruitment.

Trophodynamic (species interactions) shifts in the North Pacific ecosystem could also influence recruitment in Pacific cod. Bailey (2000) has shown that recruitment control of walleye pollock, another North Pacific gadid, shifted from the larval to the juvenile stage in the Gulf of Alaska, primarily due to increased predation by arrowtooth flounder on immature pollock. Pacific cod juveniles may be similarly vulnerable to the effects of increased groundfish predation, resulting in additional density-dependent regulation during the juvenile stage, which would be superimposed on that associated with habitat limitation.

The shifting distributions of adult Pacific cod throughout the year indicate seasonal migrations. Pre-spawning Pacific cod occur primarily over the inner and middle shelves of the Bering Sea (<30-100 m depths) in summer. In winter (January-March) Pacific cod appear to aggregate in major spawning areas between Unalaska and Unimak islands in the eastern Aleutian Islands and near the Shumagin Islands. Postspawning dispersal occurs in summer when Pacific cod move from deep off-shelf waters to shallower depths on the eastern Bering Sea shelf (Shimada and Kimura ,1994). Pacific cod may be vulnerable to the effects of fishing since they form large spawning aggregations and demonstrate some spawning site fidelity. Adult Pacific cod are opportunistic feeders and eat both invertebrate (shrimp, crabs, squid) and vertebrate prey (piscivory) (Yang 2003).

Overexploitation of large fish predators can cause complex changes in community dynamics by altering recruitment and survival patterns. In this case, fishing large, piscivorous species such as Pacific cod may cause a trophic release from predation, especially among the juvenile stages of small pelagic fishes (ex: juvenile gadids and forage fishes). These cascading increases in the abundances of small forage fishes such as capelin, herring, eulachon, age-0 walleye pollock, and age-0 Pacific cod, could result in increased overlap among these species and life history stages, exacerbating the potential for competition among individuals for resources such as prey and habitat. Previous work on walleye pollock in the Gulf of Alaska has shown that there is significant potential for competition between age-0 pollock and yearling capelin (Wilson *et al.* 2006).

ABC as Recommended in the Most Recent Stock Assessments

In 2007, a massive effort was undertaken to consider a large number of alternative assumptions in the EBS assessment model. This effort included a technical workshop that reviewed 40 model configurations and resulted in 40 suggestions for further investigation, examination of an enormous array of alternative models before selecting four models to present in the preliminary SAFE report, and examination of another enormous array of alternative models before selecting four models to present in the final SAFE report (Thompson et al. 2007). Unfortunately, the effort required to develop the 2007 BSAI assessment left insufficient time for a full and timely completion of the 2007 GOA assessment. Although a SAFE report chapter was produced for Pacific cod in 2007, it was incomplete and late, and was rejected by both the Plan Team and the Scientific and Statistical Committee.

For many years, Pacific cod in both the BSAI and GOA have been managed under Tier 3 of the Council's ABC and OFL definitions (Amendment 56 to each of the respective FMPs), and this is still true for the BSAI stock. However, because the 2007 GOA assessment was rejected, the Plan Team and SSC were required to develop their ABC and OFL recommendations for GOA Pacific cod on other grounds. One possibility would have been to use the projections from the 2006 GOA assessment. However, these projections (which showed an upward trend) were difficult to reconcile with the results from the 2007 GOA trawl survey (which showed a downward trend). Therefore, as a precautionary measure, the Plan Team and SSC chose to recommend a 2008 OFL and a 2008 ABC for the GOA stock on the basis of the Tier 5 formulae.

Under Tier 3 of Amendment 56 to the BSAI and GOA Groundfish FMPs, the maximum permissible ABC depends on the relationship of projected spawning biomass to $B_{40\%}$. For the BSAI, the preferred model in the 2007 assessment projected a 2008 spawning biomass of 398,000 mt, about 26 percent below the $B_{40\%}$ estimate of 540,000 mt, leading to a maximum permissible ABC of 150,000 mt (Thompson et al. 2007). However, the SSC rejected the assessment's estimate of $B_{40\%}$, and instead recommended a 2008 ABC of 176,000 mt, reasoning that a catch of this magnitude would not violate the Tier 3 formula under a more accurate estimate of $B_{40\%}$.

Under Tier 5 of Amendment 56, the maximum permissible ABC is equal to the product of current biomass and 75% of the natural mortality rate. The Plan Team and SSC determined that the natural mortality rate for GOA Pacific cod is 0.38, based on life history theory. The 2007 trawl survey biomass estimate (233,310 mt) was taken to be the best estimate of current biomass. Substituting these values into the Tier 5 formula gave a 2008 ABC of 66,493 mt.

4.2.4.3 Atka Mackerel

The recruitment history of Atka mackerel is characterized by variable but fairly good recruitment throughout the time series of stock assessment estimates. The strong 1999 year class is most notable followed by the 1988, 1977, and 2001 year classes (Lowe *et al.* 2007). The most recent stock assessment estimates above average (greater than 20% of the mean) recruitment from the 1977, 1986, 1988, 1992, 1995, 1998, 1999, 2000, and 2001 year classes (Lowe *et al.* 2007). Given the history of variable, but widespread consistent recruitment for BSAI Atka mackerel, it is more likely that recruitment is largely driven by environmental factors than fishery management measures. Based on basin-wide North Pacific climate indices, there appears to have been a major regime shift in 1976/77 and a minor regime shift in 1988/89 (Boldt 2005, Hare and Mantua 2000, King 2005). There is some uncertainty if there was a regime shift in 1999 given the variability in environmental indices since 1998 (Rodionov *et al.* 2005). These hypothesized regime shifts coincide with the three strongest Atka mackerel year classes, however, it should noted that the mechanisms which produce successful recruitment are unknown.

ABC as Recommended in the Most Recent Stock Assessments

In 2008, Bering Sea/Aleutian Islands Atka mackerel were placed into Tier 3a of the ABC/OFL definitions, which requires reliable estimates of biomass, $B_{40\%}$, $F_{35\%}$, and $F_{40\%}$. Under the definitions and current stock conditions, the overfishing fishing mortality rate is the $F_{35\%}$ rate which was estimated to be 0.398 for Atka mackerel and equated to a yield of 71,400 t (Lowe *et al*. 2007b). The maximum allowable fishing mortality rate for ABC (F_{ABC}) is the $F_{40\%}$ rate which was estimated to be 0.331 for Atka mackerel in 2008, which translated to a yield of 60,700 t (Lowe *et al*. 2007b). The 2008 TAC was set equivalent to ABC at 60,700 t.

Gulf of Alaska Atka mackerel fall into Tier 6 of the ABC/OFL definitions, which defines the overfishing level as the average catch from 1978 to 1995, and that ABC cannot exceed 75 percent of the OFL. The average annual catch from 1978-95 is 6,200 t; thus ABC cannot exceed 4,700 t. The current ABC recommendation from the stock assessment is equal to the maximum prescribed under Tier 6, however, the stock assessment suggests that prudent management is still warranted and reiterated the rationale as given in the past for a TAC to provide for anticipated bycatch needs of other fisheries, principally for Pacific cod, rockfish and pollock, and to only allow for minimal targeting (Lowe *et al*. 2007a). The 2007 and 2008 TACs for GOA Atka mackerel were 1,500 t.

4.2.4.4 Pacific Herring

Pacific herring (*Clupea pallasi*), is a marine fish species with moderate fecundity producing thousands of eggs per individual spawner (Paulson and Smith, 1977). Pacific herring spawn in the spring period in near shore regions throughout the Gulf of Alaska and the Bering Sea. In the GOA major spawning locations occur near Sitka Alaska and Prince William Sound (Williams and Quinn, 1998, Hulson et al. 2007). In the Bering Sea, major spawning concentrations can be found in Bristol Bay near the village of Togiak and in Norton Sound (Funk and Rowell, 1995; Williams and Quinn, 1998). In the Bering Sea, herring migrate to one of two major wintering grounds located in northern and southern regions of the outer domain (Tojo et al., 2007). Comparison of recruitment time series of Pacific herring across the northwest Pacific reveals that this species exhibits episodic recruitment events that show some evidence of synchrony at a regional scale (Williams and Quinn, 2000a).

Several hypotheses have been advanced to explain recruitment trends in Pacific herring. Quinn et al. (2001) and Marty (2003) reported that disease may have contributed to the decline in spawning biomass of Pacific herring in Prince William Sound. Disease may have resulted in a weakened condition due to inadequate energy stores resulting from poor feeding conditions (Hulson et al. 2007). An alternative hypothesis suggests that large scale shifts in climate forcing can influence a variety of oceanographic factors including: timing of production, metabolic rate, larval transport, prey availability, and probability of encounters between predator and prey. Climate shifts have been recorded in the North Pacific in 1977, 1989 (Hare and Mantua, 2000). The most recent shift in atmospheric forcing occurred in 1998 with spatially differing impacts on ocean conditions in the Gulf of Alaska and Bering Sea (Bond and Overland, 2004). Intra-species competition and predator prey interactions are may also influence recruitment patterns for Pacific herring.

Shifts in large scale atmospheric forcing appears to influence the structure of marine fish communities in the western central Gulf of Alaska ecosystem through its role in determining the timing of peak production. Species that spawn in the winter will be favored by periods of early peak production, while species that spawn in the spring and summer will be favored by periods of delayed production (Mackus et al., 1997; Anderson and Piatt, 1999).

Environmental forcing can influence a variety of oceanographic factors governing survival during the early life history period. Tanasichuk and Ware (1987) found temperature effected fecundity and egg size. Alderdice and Hourston (1985) found temperature influenced embryonic survival rates. Williams and Quinn (2000b) found supplementing a Ricker type spawner recruit relationship with sea surface or air temperature produced an improvement to forecasts of Pacific herring recruitment. Climate shifts can influence major transport corridors for Pacific herring. Wespestad (1991) found recruitment trends of Togiak region were related to local wind conditions.

Ocean conditions that favor concentration of forage fish and their prey can enhance production. The FOCI program identified a potential mechanism linking increased precipitation to enhanced eddy formation and reduced larval mortality. Eddies are believed to provide a favorable environment for pollock larvae by increasing the probability of encounters between larvae and their prey (Megrey et al., 1996). An inverse or dome shaped relationship exists between the amount of wind mixing and pollock fish production. Bailey and Macklin (1994) compared hatch date distributions of larval pollock with daily wind mixing. This analysis showed that first feeding larvae exhibited higher survival during periods of low wind mixing. Research is needed to determine whether this mechanism may be important for Pacific herring.

Evidence suggests that in some years, fish predation may exhibit a measurable effect on forage species production in the Gulf Ecosystem Monitoring study region. Anderson and Piatt (1999) noted that the post regime shift increase in gadoid and pleuronectid fishes coincided with marked declines in capelin and shrimp populations. They proposed that this out phase relationship could be caused by increased predation mortality due to an increase in piscivorous species. This mechanism appears to influence walleye pollock and may be important to Pacific herring. Bailey (2000) provided evidence that during the 1980s, pollock populations were largely influenced by environmental conditions, whereas, after the mid-1980s, there was a greater juvenile mortality resulting from the buildup of large fish predator populations.

Detailed studies of Prince William Sound reveal that interspecific competition for common prey resources can result in complex recruitment patterns (Norcross et al., 2001). In Prince William Sound, Cooney (1993) speculated that pollock predation could explain some of the observed trends in juvenile salmon and Pacific herring survival. They suggested that years of high copepod abundance were associated with high juvenile salmon survival because pollock relied on an alternative prey resource.

At finer spatial scales prey resources for forage fish may be prey limited leading to resource partitioning to minimize competition between forage fish species that occupy similar habitats. Willette et al. (1997) examined the diets of juvenile walleye pollock, Pacific herring, pink salmon and chum salmon in PWS. Their study revealed that two species pairs (walleye pollock and Pacific herring, and pink and chum salmon) exhibited a high degree of dietary overlap. This finding suggests that in PWS, competition for food resources may occur within these pairs when food abundance is limited. Foy and Norcross (1999) found water transported into Prince William Sound influenced the spatial and temporal distribution of prey for age-0 Pacific herring within Prince William Sound resulting in fine scale partitions in the condition of age-0 Pacific herring within the sound.

Competition for prey and oceanographic factors influencing prey availability can influence the probability of over-wintering survival for juvenile herring. Juvenile herring rely on fat resources acquired during the summer growing season during the winter (Foy and Paul, 1999). Interspecies competition for common prey can produce complex recruitment patterns.

4.3 Impacts of Human Activities on Steller Sea Lions

4.3.1 Subsistence Harvests of Steller Sea Lions

Both the ESA and the MMPA contain provisions that allow coastal Alaska Natives to harvest endangered, threatened, or depleted species for subsistence purposes. Prior to 1992, no comprehensive program estimated the level of subsistence harvest of sea lions in Alaska. Haynes and Mischler (1991) examined historical data on subsistence uses and summarized the limited data on contemporary harvest levels and uses. Available information indicated that sea lions were being harvested at several villages on the Bering Sea, in the Aleutian Islands, in Prince William Sound, the Kodiak Archipelago, Lower Cook Inlet (Haynes and Mishler 1991). The most recent year for which subsistence data have been summarized is 2007. During 1992-2007, harvest data were collected through systematic retrospective interviews with hunters in at least 60 coastal communities throughout the range of sea lions in Alaska (e.g., Wolfe *et al.* 2005,Wolfe *et al.* 2008, Wolfe *et al*. 2009). Results show the annual take (i.e., harvest plus struck and loss) decreasing substantially from about 550 sea lions in 1992 to less than 200 in 1996 followed by annual takes between 164 and 217 from 1997 to 2007. Wolfe et al. (2009) give the following totals for the reported take in subsistence hunts by year: 1992: 549; 1993: 487; 1994:416; 1995: 339; 1996:186; 1997:164; 1998:178; 1999: no data given; 2000: 171; 2001: 198; 2002:185; 2003:212; 2004: 216; 2005:218; 2006:187; 2007:217). (Table III-1). Confidence intervals on these estimates are wide (e.g., the 95% confidence interval in 2007 of 147 to 324 sea lions taken. Reported strike and loss rates are also relatively high. For example in 2007, 23.6% of the total reported take was struck but lost whereas 76.4% were harvested.

Estimated takes of western DPS Steller sea lions by Alaska Natives in five regions. Values include both retrieved harvest and reported struck and lost (Wolfe *et al.* 2005). PWS = Prince William Sound; AK = Alaska. See text for data from 2005-2007.

Year	**PWS-Cook Inlet**	**Kodiak & AK Peninsula**	**Aleutian Islands**	**Pribilof Islands**	**Bristol Bay**	**Total**
1992	40	60	135	297	9	541
1993	46	64	124	245	6	485
1994	27	67	122	193	1	410
1995	31	144	96	68	0	339
1996	17	65	58	46	0	186
1997	6	46	52	56	4	164
1998	28	27	37	78	0	170
2000	17	32	76	43	0	168
2001	16	47	98	38	0	199
2002	6	24	105	43	0	178
2003	25	41	107	32	0	205
2004	54	21	96	32	1	204
Averages						
1992-95	36	84	119	201	4	444
1996-04	21	38	79	46	1	184

In the early 1990s, juveniles were harvested at least twice as much as adults, yet that ratio declined beginning in 1996, and during 2000 to 2004 the ratio of juveniles to adults in the harvest ranged from 0.5 to 1.0. In 2007, the reported ratio was about equal (juveniles: 50.8%, adults: 49.2%). The ratio of males to females harvested in 2007 was 2.6 1.8, below the 5-year average of 4.1 during the previous five years. However, there is high uncertainty about the sex ratio of animals taken, as sex is reported as "unknown" for 30% of the animals taken. The reported sex ratio of harvested animals has varied substantially in different years (e.g., in 2004, the ratio was 1.8). In 2007, a total of 25.6 adult females were harvested, representing about 15% of the total harvest of known sex and age. This percentage has also varied substantially in different years.

During 1992-1995, the greatest numbers of sea lions harvested were in the Pribilof Islands, whereas during 1996-2004 the harvest was greatest in the Aleutian Islands. In 2007, the highest level of reported take occurred also in the Aleutian Islands (total = 61.3), the Pacific Rim (villages in Lower Cook Inlet, Prince William Sound, and Resurrection Bay) (total = 47.5), and the Pribilof Islands (total = 31.3) (see Table 14 in Wolfe et al. 2009). Only 6.1 sea lions were reported taken from a single village in southeast Alaska. While the North Pacific Rim grouping in Wolfe et al.(2009) includes villages in Resurrection Bay and lower Cook Inlet, no sea lions were reported taken from Homer northward in Cook Inlet or in Resurrection Bay in 2007. The surveys that produced these estimates covered all Alaskan communities that regularly hunt Steller sea lions, but a few additional animals are taken occasionally at other locations (Coffing *et al.* 1998, ADF&G unpublished data).

In 1998, the Tribal Government of St. Paul's Ecosystem Conservation Office implemented a real-time data collection program to estimate the take of sea lions, due to concerns by hunters and the local community in the uncertainty of harvest results based on retrospective surveys. Results of the real-time harvest monitoring indicated a sea lion take of about 25-35 per year from 1998-2002, followed by a reduced take of 18 sea lions in both 2003 and 2004 (Zavadil *et al.* 2005). The Tribal government also implemented a new subsistence harvest management scheme that likely may have resulted in fewer animals taken. Factors that may be responsible for this decreased take include fewer hunters, fewer animals to hunt in the communities' hunting areas, and voluntary restraint from hunting because of perceived problems with the sea lion population (Wolfe and Hutchinson-Scarbrough 1999).

Information on the harvest of Steller sea lions in Russia is fragmentary. In 1932 and 1933, newborn pups were harvested on Iony Island in the Sea of Okhotsk (1,198 and 805 respectively), and in 1935 about 30 pups were taken on the Shipunsky Cape (Kamchatka) rookery (Nikulin 1937). In 1974, an experimental harvest was conducted on Brat Chirpoev rookery in the Kuril Islands that took 296 pups (Perlov 1975). During the period when the government of the Soviet Union conducted commercial sealing (1960-1990), sea lions were not a target species, but they were taken occasionally with annual harvests ranging from 37 to 650 animals (Perlov 1996). During the 1950s to 1980s, a subsistence harvest was conducted on the Commander Islands and Kamchatka that usually took fewer than 100 animals a year, but this harvest has stopped completely in the late 1980s (Burkanov personal communication). Some sea lions are taken in Chukotka by native hunters, but the number killed is unknown.

Current subsistence harvests represent a large proportion of the potential biological removal that was calculated for the western DPS of Steller sea lion (Angliss and Outlaw 2005). However, subsistence harvests account for only a relatively small portion of the Steller sea lions lost to the population each year and are primarily young males which reduce the impact to the recovery of the population.

4.3.2 Commercial Harvest of Steller Sea Lions

Currently, no commercial harvest for Steller sea lions exists in the United States, but sea lions were commercially harvested prior to 1973. A total of 616 adult males and 45,178 pups of both sexes were harvested in the eastern Aleutian Islands and Gulf of Alaska between 1959 and 1972 (Thorsteinson and Lensink 1962, Havens 1965, Merrick *et al.* 1987). The pup harvests, which sometimes reached 50% of the total pup production from a rookery, could have depressed recruitment in the short term and may partially explain the declines at some sites through the mid-1970s. However, these harvests do not explain why numbers declined in regions where no harvest occurred, or why in some regions declines occurred approximately 20 years after harvests ceased (Merrick *et al.* 1987). A comparative analysis of the ecology and population status of four species of pinnipeds in similar environments (Steller sea lions in the Gulf of Alaska, Cape fur seals in the Benguela Current, harp seals in the Barents Sea, and California sea lions in the California Current) indicates that directed commercial harvest was not a major factor in the Gulf of Alaska Steller sea lion decline (Shima *et al.* 2000).

Steller sea lions are hunted in Hokkaido, Japan to reduce interaction with local fisheries, with an average of 631 animals killed per year during 1958-1993 (Takahashi and Wada 1998). The animals killed had probably migrated southward from the Kuril Islands. Demographic modeling shows that kills were sufficient to deplete the Kuril population, especially in combination with incidental catches in fisheries (Takahashi and Wada 1998). More current information on the level of kill since 1993 is not available.

4.3.3 Incidental Take by Fisheries

<u>Western DPS U.S. waters</u>.--Many Steller sea lions have been killed incidental to commercial fishing operations in the Bering Sea and North Pacific Ocean. The total estimated incidental catch of Steller sea lions during 1966-1988 in foreign and joint-venture trawl fisheries operating off Alaska was over 20,000 animals (Perez and Loughlin 1991). A particularly high level of take occurred in the 1982 Shelikof Strait walleye pollock joint venture fishery when U.S. trawlers killed an estimated 958 to 1,436 sea lions (Loughlin and Nelson 1986). The estimated take in this fishery declined to fewer than 400 animals per season in 1983 and 1984, probably due to changes in fishing techniques and in the area and times fished. Most of the animals taken were sexually mature females. Fewer than 100 per year were estimated to have been taken during 1985-1987. The level of incidental mortality has continued to decline (see below).

Amendments to the MMPA in 1988 and 1994 required observer programs to monitor marine mammal incidental take in some domestic fisheries. Observers monitored the Prince William

Sound drift gillnet fishery in 1990 and 1991 and estimated a mean annual kill of 14.5 Steller sea lions (Wynne *et al.* 1992). Hill and DeMaster (1999) provide observer-based estimates of average annual Steller sea lion incidental mortality for fisheries operating in the range of the western DPS between 1993 and 1997 as follows: 6.8 animals in the Bering Sea groundfish trawl fishery; 1.2 animals in the Gulf of Alaska groundfish trawl fishery; 0.2 animals in the Bering Sea groundfish longline fishery; and 1.0 animals in the Gulf of Alaska groundfish longline fishery. These numbers are minimum estimates of the incidental kill and serious injury in fisheries, because not all fisheries that might take sea lions are covered by observers.

The minimum estimated mortality rate incidental to commercial fisheries in 2002 was 29.5 sea lions per year, based on observer data (24.1) and self-reported fisheries information (5.2) or stranded data (0.2) where observer data were not available (Angliss and Outlaw 2005).

In the most recent stock assessment for the western DPS of Steller sea lion, Angliss and Allen (2008) reported an estimated mean annual mortality rate in the observed fisheries of 25.8 (CV = 0.60) sea lions per year from this stock. This estimate combined mortality estimates from the Bering Sea and GOA groundfish trawl and Gulf of Alaska longline fisheries with mortality estimates from the Prince William Sound salmon gillnet fishery. The latter fishery, however, was last observed in 1991. Angliss and Allen (2008) provided a minimum estimated mortality rate incidental to U.S. commercial fisheries of 26.2 animals based on the aforementioned observer data and stranding data. However, currently used stranding data likely underestimates the actual rate of entanglement since "not all entangled animals strand and not all stranded animals are found or reported" (Angliss and Allen 2008a:6).

Russian waters.-- Nikulin and Burkanov (2000) documented marine mammal bycatch in Japanese salmon driftnet fishing in the Russian exclusive economic zone of the southwestern Bering Sea. Catch of only one Steller sea lion was observed during 1992-1999, and it was released alive. Quantitative information on sea lion incidental catch in other fisheries that occur in Russian and Japanese waters is not available, but it is possible that some animals have been killed in trawl fisheries for herring and pollock.

During October-December 2002, observers recorded the incidental take of sea lions during a herring trawl fishery in the western Bering Sea. Preliminary estimates of the total number of sea lions caught were 35-60, with 32-50 killed (Burkanov and Trukhin unpublished). The genetic analysis of skin samples from sea lions caught in this trawl fishery will provide insight on which regions the sea lions may be from (i.e., Aleutian, Commander, and Kuril Islands, and Kamchatka). The majority, if not all, of these sea lions were subadult males. Observers on vessels fishing for herring during the 2002-2003 seasons in the Bering Sea in Russia observed 15 sea lions killed[15] (Waite and Burkanov 2005).

Eastern DPS.--In the most recent stock assessment for the eastern DPS, Angliss and Allen (2008) reported that fishery observers monitored four commercial fisheries during the period from 1990 to 2005 in which incidental take of Steller sea lions from this stock was reported.

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[15] The most common prey found in the stomachs of these incidentally caught sea lions was Pacific herring (FO=100%) and pollock (FO=76.9%) (Waite and Burkanov 2005).

These fisheries were: the Gulf of Alaska sablefish longline fishery, the California (CA)/Oregon (OR) thresher shark and swordfish drift gillnet fishery, the WA/OR/CA groundfish trawl fishery, and the Northern Washington (WA) marine set gillnet fishery. In 2001-2003, one Steller sea lion was observed killed in each year in the WA/OR/CA groundfish trawl. There have been no observed serious injuries or mortalities incidental to the CA/OR thresher shark and swordfish drift gillnet fishery in recent years (Angliss and Allen 2008, citing Carretta 2002, Carretta and Chivers 2003, Carretta and Chivers 2004).

No Steller sea lion mortalities have been reported by observers in the Gulf of Alaska sablefish longline since 2000 (Perez unpubl. ms., as cited in Angliss and Allen 2008). A mean estimated annual mortality level of 0.8 was calculated based on the level of the aforementioned observer takes in combination with a mortality that occurred in an unmonitored haul (see Table 5 of Angliss and Allen 2008). No data are available after 1998 for the northern Washington marine set gillnet fishery. While mortalities associated with drift gillnet and set gillnet fisheries in Washington and Oregon in previous decades, none have been reported by observers monitoring these fisheries this decade (Angliss and Allen 2008). Based on available data, Angliss and Allen (2008) provided a minimum total annual mortality of eastern DPS Steller sea lions in both Canadian and U.S. waters of 1.4 (stranding data =0.6 and observer data = 0.8). It is likely the rate of entanglement is substantially underestimated.

Angliss and Allen (2008) also reported that Steller sea lions were killed during commercial salmon farming operations in British Columbia. Between 1999-2003, an average of 47.75 Steller sea lions were killed annually in this fishery (Olesiuk 2004). Angliss and Allen reported that, as of 2004, aquaculture facility personnel are no longer permitted to shoot Steller sea lions.

4.3.4 Intentional and Illegal Shooting

In some areas Steller sea lions are known to have been shot deliberately by fishermen (and perhaps other people), but it is unclear how such mortality may affect the population because the overall magnitude of the take is unknown (Alverson 1992). One of the few estimates of shooting mortality was reported by Matkin and Fay (1980), who calculated that 305 Steller sea lions were shot and killed while interfering with fishing operations in the spring 1978 Copper River Delta salmon gillnet fishery. Data from a 1988-1989 study of the Copper River salmon gillnet fishery indicated that the level of directed kill of sea lions was significantly less than during 1978 (Wynne 1990). However, the two studies are not directly comparable due to differences in methodologies and periods and locations sampled. During the 1960s, sea lions were sometimes killed and used as bait by crab fishermen (Alverson 1992). Such killing may have had a significant effect in local regions and might have caused animals to move away from certain rookeries and haulout sites (Loughlin and Nelson 1986, Merrick *et al.* 1987, NRC 2003). In 1990, a regulation was implemented to prohibit fishermen from discharging firearms near Steller sea lions, but nonetheless some shooting, resulting in an unknown level of mortality, likely occurs (NMFS 2001, Loughlin and York 2000, NRC 2003). It is difficult to estimate this take. Sea lions found shot are not assumed to be illegal, as the animal may have been shot and lost by a subsistence hunter.

Simulation modeling suggests that a combination of commercial harvests, subsistence harvests, and intentional and incidental take in fisheries may explain a large portion of the western Steller sea lion population decline that occurred through 1980 (Trites and Larkin 1992). However, the annual decline since 1990 has been much greater than can be accounted for by such direct causes (Loughlin and York 2000).

4.3.5 Entanglement in Marine Debris

Steller sea lions may become entangled in lost and discarded fishing gear and other marine debris, including items such as closed packing bands and net material (Calkins 1985). A study conducted in the Aleutian Islands during June-July 1985 to investigate the rate of entanglement found that a very low percentage (approximately 0.07%) of observed sea lions were entangled in net or twine; none were entangled in packing bands (Loughlin *et al.* 1986). A follow-up study was conducted during November 1986 to assess the possibility that sea lion pups were becoming entangled in debris. Researchers saw no entangled pups and only one entangled juvenile out of a total of 3,847 sea lions examined (Loughlin *et al.* 1986). However, these observational studies cannot fully evaluate the frequency of entanglement because entangled animals may die at sea and thus not be observed on land. Observations by researchers in southeast Alaska indicate higher numbers of sea lions entangled in fishing gear and other marine debris which could be limiting the populations growth rate (Pitcher *et al.* in press).

4.3.6 Impact to Water Quality Due to Human Population Growth in the Action Area

As the size of human communities increases, there is an accompanying increase in habitat alterations for housing, roads, commercial facilities, and other infrastructure. The impacts of these activities on landscapes and the biota they support increases as the size of the human population expands. The Alaska population has increased by almost 50 percent in the past 20 years, most of that increase has occurred in the Cities of Anchorage and Fairbanks. Outside of the City of Anchorage, few of the cities, towns, and villages would be considered urbanized. Despite low levels of industrialization in the action area, some commercial and industrial facilities in the action area have had, or have the potential for significant, adverse effects on the terrestrial, coastal, and marine environments, primarily because of their potential effects on water quality.

Four superfund sites occur in the action area: Adak Naval Air Station (Aleutians West), Elmendorf Air Force Base (Borough of Anchorage), Fort Richardson Army Base (Borough of Anchorage), and the U.S. Department of Transportation's Standard Steel and Metals Salvage Yard (Borough of Anchorage).

The Naval Air Station at Adak covers about 64,000 acres on the Island of Adak near the western end of the Aleutian Island archipelago. Adak Island became a military base in 1942 and has been controlled by the U.S. Navy since 1950. In 1986, the Navy identified 32 areas that potentially received hazardous substances, including chlorinated solvents, batteries, and transformer oils containing polychlorinated biphenyls (PCBs) over a period of 40 years. Investigations on the island focused on two areas: the Palisades Landfill and Metals Landfill. Disposals had stopped at the Palisades landfill in the 1970s and the landfill was covered. The

Metals landfill contains a hazardous waste pile under the Resource Conservation and Recovery Act and a closure plan is being developed for the site.

The cities of Kodiak and Unalaska both have wastewater treatment plants, along with the City of Anchorage and several cities in the Kenai borough. Most of the industrial facilities in the action area (outside of Anchorage and the Kenai Borough) are involved in seafood processing. Canneries or land-based processors occur at Adak, Anchorage, Chignik, Cordova, Dillingham, Egegik, Emmonak, False Pass, Homer, Kenai, King Cove, King Salmon, Kodiak, Larsen Bay, Nikiski, Ninilchik, Nome, St. Paul, Sand Point, Savoonga, Seward, Soldotna, Togiak, Toksook Bay, Unalaska, Valdez, and Whittier.

In the 1970s, fish and shellfish waste discharged from mobile and shore-based processors at Kodiak, Dutch Harbor, and Akutan polluted coastal waters around those communities (Jarvela 1986). In 1976, waste was discharged at Dutch Harbor. In 1983, the shore-based Trident Seafoods plant at Akutan released cod and crab wastes into Akutan Harbor before the plant was destroyed by fire. Sonar surveys of Akutan Harbor identified a waste pile that was about 7 m thick and 200 m in diameter. In 1998, the list of impaired waters that was prepared by the Alaska Department of Environmental Conservation included water bodies in Cold Bay, Dutch Harbor, and Kodiak that had been impaired by seafood processing, logging operations, military materiel, or fuel storage. Although total maximum daily loads will not be developed for these facilities before this biological opinion is completed, the effects of these facilities appear to be localized and would not be expected to adversely affect threatened or endangered species under NMFS' jurisdiction.

As the human population expands, the risk of disturbance to listed species in the action area, especially Steller sea lions, also increases. Several studies have noted the potential adverse effects of human disturbance on Steller sea lions. Calkins and Pitcher (1982) found that disturbance from aircraft and vessel traffic has extremely variable effects on hauled-out sea lions. Sea lion reaction to occasional disturbances ranges from no reaction at all to complete and immediate departure from the haulout area. The type of reaction appears to depend on a variety of factors. When sea lions are frightened off rookeries during the breeding and pupping season, pups may be trampled or even abandoned in extreme cases. Sea lions have temporarily abandoned some areas after repeated disturbance (Thorsteinson and Lensink 1962), but in other situations they have continued using areas after repeated and severe harassment. Johnson *et al.* (1989) evaluated the potential vulnerability of various Steller sea lion haulout sites and rookeries to noise and disturbance and also noted a variable effect on sea lions. Kenyon (1962) noted permanent abandonment of areas in the Pribilof Islands that were subjected to repeated disturbance. A major sea lion rookery at Cape Sarichef was abandoned after the construction of a light house at that site, but then has been used again as a haulout after the light house was no longer inhabited by humans. The consequences of such disturbance to the overall population are difficult to measure. Disturbance may have exacerbated the decline, although it is not likely to have been a major factor.

4.3.7 Disturbance

The possible impacts of various types of disturbance on Steller sea lions have not been well studied, yet the response by sea lions to disturbance will likely depend on season, and their stage in the reproductive cycle (Kucey and Trites 2006). Close approach by humans, boats, or aircraft will cause hauled out sea lions to go into the water, and can cause some animals to move to other haulouts (Calkins and Pitcher 1982, Kucey 2005). The discharge of firearms at or near hauled out animals may have a particularly dramatic effect. Vessels that approach rookeries and haulouts at slow speed, in a manner that sea lions can observe the approach have less effect than fast approaches and a sudden appearance. Sea lions may become accustomed to repeated slow vessel approaches, resulting in minimal response. Although low levels of occasional disturbance may have little long-term effect, areas subjected to repeated disturbance may be permanently abandoned (Kenyon 1962, Thorsteinson and Lensink 1962). When humans set foot on a rookery or haulout, the response by sea lions is typically much greater, often resulting in stampedes that may cause trampling or abandonment of pups (Calkins and Pitcher 1982, Kucey 2005, Lewis 1987, Kucey 2005). In British Columbia, harassment and killing that occurred prior to 1970 resulted in the abandonment of one major rookery, although it is now used as a haulout (Bigg 1988).

Since Steller sea lions were afforded ESA protection in 1990, regulations have been in place to minimize disturbance of animals by humans, especially on rookeries. An unknown level of disturbance still occurs with current regulations. Repeated disturbances that result in abandonment or reduced use of rookeries by lactating females could negatively affect body condition and survival of pups through interruption of normal nursing cycles. The consequences of such disturbance to the overall population are difficult to measure. Disturbance may have contributed to or exacerbated the decline, although it is not likely to have been a major factor.

4.3.8 Impacts of Oil and Gas Development

Oil and gas leasing and exploration has occurred in many parts of the Steller sea lion range, including California, Cook Inlet, the Gulf of Alaska, the North Aleutian Basin, and Russia. Since the 1970s, the Minerals Management Service has made blocks of the Outer Continental Shelf off Alaska available for oil and gas leases in primarily Cook Inlet, but also other locations in the Steller sea lion range. Except for two active leases in lower Cook Inlet, all of the leases in Alaska have either expired or been relinquished. Lease sales are currently proposed in the MMS 5-year plan for Cook Inlet and the north Aleutian Basin. On October 15, 1993, NMFS completed a biological opinion on the Cook Inlet lease sale (lease sale Number 149), which concluded that the lease and associated exploration activities were not likely to jeopardize the continued existence of any listed or proposed species, nor were they likely to destroy or adversely modify critical habitats. That biological opinion recognized the proximity of the lease area to important sea lion rookeries and haulouts in Shelikof Strait, the use of the Strait by foraging sea lions, and its value as an area of high forage fish production, but recognized the low probability of oil spills during exploration activities. NMFS (2003) reached the same conclusion after a programmatic consultation on the MMS proposed lease sales 191 and 199. In 1995, NMFS conducted a section 7 consultation with the Minerals Management Service and concluded that the lease sale and exploration activities for the proposed oil and gas Lease Sale

Number 158, Yakutat were not likely to jeopardize the continued existence of any listed or proposed species, nor were the activities likely to destroy or adversely modify critical habitats (NMFS 1995).

The State of Alaska also manages oil and gas leasing in Alaska. In 1896, oil claims were staked at Katalla approximately 50 miles south of Cordova. Oil was discovered there in 1902. An on-site refinery near Controller Bay produced oil for over thirty years. The refinery burned down in 1933 and was not replaced. Exploration in Cook Inlet began in 1955 on the Kenai Peninsula in the Swanson River area, and oil was discovered in 1957. Today, a number of active fields produce oil in Cook Inlet, all of which is processed at the refinery at Nikiski on the Kenai Peninsula. Estimated oil reserves in Cook Inlet are 72 million barrels of oil. Currently there are additional lease sales planned through 2005 for the Cook Inlet area, and for the North Aleutian basin area.

One of the biggest oil and gas developments in the world is being developed about 15 kilometers offshore Sakhalin Island in the sea of Okhotsk (Sakhalin II) where massive oil field and gas field developments feed two 800 kilometer pipelines to an LNG plant, an oil export terminal, and waiting tankers.

Oil and gas in the range of the Eastern DPS.—there are multiple active leases and oil-producing platforms in areas off parts of California, including the Santa Barbara channel, the Long Beach-San Pedro Basin area, and the Santa Maria Basin (maps available at http://www.mms.gov/omm/pacific/lease/maps.htm). Within the proposed action area, the MMS Draft Proposed Program for 2010-2015 includes proposed lease sales in the North Aleutian Basin (2 sales), Cook Inlet(2 sales), Southern California (2 sales), and Northern California (1 sale) (see schedule at http://www.mms.gov/5-year/PDFs/2010-2015/DPP%20FINAL%20(HQPrint%20with%20landscape%20maps,%20map%2010).pdf). As the MMS has not yet consultted with NMFS on these sales and associated activities, we don't consider their potential effects further.

Oil spills are expected to adversely affect Steller sea lions if they contact individual animals, haulouts, or rookeries when occupied, or large proportions of major prey populations (Minerals Management Service 2003). It is well-documented that exposure of at least some mammals to petroleum hydrocarbons through surface contact, ingestin, and particularly inhalation can be harmful. Surface contact with the low-molecular weight fractions can cause temporary or permanent damage of the mucous membranes and eyes, and/or epidermis (see section IV.F.3 in MMS (2006). Contact with crude oil can damage eyes. Corneal ulcers and abrasions, conjunctivitis, and swollen nicitating membranes were observed in captive ringed seals place in crude oil-covered water and in seals in the Antarctic after an oil spill. Corneal ulcers and scarring were observed in others captured in oiled areas (Monnett and Rotterman 1989) and in oiled otters brought to post-EVOS treatment centers. Ingestion of petroleum hydrocarbons can lead to subtle and progressive organ damage or to rapid death. Inhalation of volatile hydrocarbon fractions of fresh crude oil can damage the respiratory system, cause neurological disorders or liver damage, have anesthetic effects, and if accompanied by excessive adrenalin release, can cause sudden death (e.g., Geraci 1988). Many PAHs are teratogenic and embryotoxic in at least some mammals. Ingestion of oil by pregnant females can negatively affect the birth weight of their young. As summarized by MMS (2006:90): "There are few post spill studies with sufficient details to reach firm conclusions about the effects, especially the long-term effects, of an oil spill on free-ranging populations of marine mammals."

Sea lions would be particularly vulnerable if large amounts of crude oil coated rookeries when young pups were on the rookeries or oil contaminated concentrations of prey. The extent to which sea lions avoid areas that have been oiled is not known. Groups and individual sea lions observed in Prince William Sound and the Gulf of Alaska after the Exxon Valdez oil spill did not appear to avoid oiled areas (Calkins and Becker 1990). Sea lions were sighted swimming in or near oil slicks, oil was seen near numerous haulout sites, and oil fouled the rookeries at Seal Rocks and Sugarloaf Island (Calkins *et al.* 1994). All of the sea lions collected in Prince William Sound in October 1989 had high enough levels of metabolites of aromatic hydrocarbons in the bile to confirm exposure and active metabolism at the tissue level. As noted above, no evidence indicated damage caused to sea lions from toxic effects of the oil (Calkins *et al.* 1994). However, studies after EVOS on sea lions were hampered by a lack of baseline on key health, condition and population parameters to enable the type of detailed study needed to discern chronic effects. Because of the ongoing decline in the western DPS, it was determined it would be difficult or impossible to distinguish an oil spill effect and thus, the focused studies needed to determine if there were, or were not, long term effects were not undertaken.

4.3.9 Impacts of Research

We give further detail on effects of research in the "Effects" section of this document.

Intentional lethal take.--Steller sea lions have been killed for scientific research since the end of World War II (Thorsteinson and Lensink 1962, Calkins and Pitcher 1982, Calkins and Goodwin 1988, and Calkins *et al.* 1994). In 1959, 630 sea lions bulls were killed in an experimental-commercial harvest and provided life history information (age, size, reproductive condition, food habits). Between 1975 and 1978, 250 sea lions were killed in nearshore waters and on rookeries and haulouts of the GOA; their stomachs were removed and examined for food content, reproductive organs were preserved for examination, blood samples were taken for disease and parasite studies, body measurements were recorded for growth studies, skulls were retained for age determination, tissue samples were preserved for elemental analysis and pelage samples were taken for molt studies. In 1985 and 1986, 178 sea lions were killed in the GOA and southeast Alaska to compare food habits, reproductive parameters, growth and condition, and diseases, with the same parameters from animals which were collected in the 1970s. The study was designed to address the problem of declining numbers of sea lions in the North Pacific and particularly in the GOA. More recently, sixteen Steller sea lions were killed for a Natural Resources Damage Assessment study following the Exxon Valdez oil spill. Thus, in the aforementioned studies, a total of 1,074 sea lions were intentionally killed for research.

Researchers have been conducting surveys and behavioral research on Steller sea lions for many decades. However, methods used during research, level of research being undertaken, and the number of people involved has changed over the years. Currently, information available in annual reports indicates that Steller sea lion populations are not adversely affected by this research, although individual animals may be adversely affected or accidentally killed. In 1998, 48,000 Steller sea lions were disturbed by these investigations, 384 pups were captured, tagged, and branded, and there were no mortalities observed. In 1997, 31,150 Steller sea lions were approached by researchers, 14,550 were disturbed, 137 were captured, and 121 were tagged, but there were no known mortalities. The studies conducted in 1996 had similar effects, although one Steller sea lions died during the study. In 1995, 7,500 Steller sea lions were disturbed and none were reported to have died.

Calkins and Pitcher (1982) found that disturbance from aircraft and vessel traffic has extremely variable effects on hauled-out sea lions ranging from no reaction at all to complete and immediate departure from the haulout. When sea lions are frightened off rookeries during the breeding and pupping season, pups may be trampled or, in extreme cases, abandoned. Sea lions have temporarily abandoned haulouts after repeated disturbance (Thorsteinson and Lensink 1962), but in other situations they have continued using areas after repeated and severe harassment. Johnson *et al.* (1989) evaluated the potential vulnerability of various Steller sea lion haulout sites and rookeries to noise and disturbance and also noted a variable effect on sea lions. Kenyon (1962) noted permanent abandonment of areas in the Pribilof Islands that were subjected to repeated disturbance. A major sea lion rookery at Cape Sarichef was abandoned after the construction of a light house at that site, but then has been used again as a haulout after the light house was no longer inhabited by humans. The consequences of such disturbance to the overall population are difficult to measure. Disturbance may have contributed to or exacerbated the decline, although Federal, State, and private researchers familiar with the data do not believe disturbance has been a major factor in the decline of Steller sea lions.

Disturbance of Steller sea lions could potentially occur, but is unlikely to occur, during aerial surveys. It is very likely to occur during capture of animals for branding, tagging, and sample collection, and may occur during close vessel approaches to rookeries and haulouts to observe branded animals. Sea lions are occasionally killed accidentally in the course of some types of scientific research activities. For example, Sea lions may be killed accidentally during anesthesia. Suffocation can result when animals are herded. Loughlin and York (2000) estimated that about three animals per year died due to research on the western DPS. However, the recent average is about 1-2 for the western DPS (NMFS unpublished data). The potential exists for additional unobserved mortality to occur following the completion of research activities. Data are not sufficient to derive reliable estimates. Pups are the age-class most vulnerable to disturbance from research activities.

On May 26, 2006, a District Court judge in DC issued an opinion and a court order relative to a law suit filed against NOAA by the Humane Society of the United States. The Humane Society argued that NOAA did not follow proper procedures under the National Environmental Policy Act before issuing permits to six entities to conduct Steller sea lion research in Alaska. The court sided with the Humane Society and directed NOAA to immediately vacate all six existing permits and prepare a full Environmental Impact Statement, per NEPA requirements. A settlement agreement was reached in June 2006 which allowed limited "No Take". "Low Take Non-Invasive Activities", and Low Take Handling and Release of Captured Animals were allowed to continue while NMFS completed an EIS on the research program. As summarized in the proposed action, that EIS as finalized in 2007 and a Summary Document has been written to update the EIS.

4.3.10 Summary of Known Direct Non-Research Related Take of Steller Sea Lions

The information below represents our best estimate of the sum of direct human related mortality factors as developed by the SSLRT up to 2004 (NMFS 2006). We have no evidence that indicates that typical rates of take from 2004-2008 differ substantially from those in the 2000-2004 period except that rates of intentional illegal shooting may have declined. Incidental catch estimates for the trawl fisheries based on observer data, were calculated by Perez and Loughlin (1990). Available quantitative information bearing on harvests, shooting, and incidental catch was compiled and analyzed by Trites and Larkin (1992). A draft analysis by a subgroup of the SSLRT extended and extrapolated the Trites and Larkin estimates. This resulted in the values below, where the cell entries are the accumulated number of deaths attributed to each cause over the interval. The historic non-subsistence direct harvest was confined to pups, and took place during a discrete subinterval, 1963-1972, of the period to which it is assigned.

	Time Period				
Mortality Source	**1958-1977**	**1977-1985**	**1985-1989**	**1989-2000**	**2000-2004**
Non-subsistence harvest	45,178	0	0	0	0
Subsistence harvest	9,995	2,900	850	3,300	750
Shooting	12,716	8,277	1,870	2,200	1,000
Incidental catch and entanglement	28,191	14,461	2,255	330	150
Total	**96,080**	**25,638**	**4,975**	**5,830**	**1,900**

4.3.11 Early Environmental Observations

Although there were no scientific surveys or collections from 100 years ago that are directly comparable with those of the last 25 to 30 years, the observations and conclusions of some of the early naturalists in Alaska are worth reviewing (Nelson 1887, Jordon *et al.* 1896, 1898, Alexander 1898a, b, Jordon and Evermann 1902). A number of early observations of the North Pacific ecosystem have been previously cited in this opinion, especially those relating to Steller sea lion food habits. Other reviews provide quotes from various early sources as well (Causey *et al.* 2005, NRC 2003). In this section we provide an overview of some of the commonly cited observations. These observations should be read with caution as they represent anecdotal information (and unpublished works) and generally were not part of a rigorous scientific study. They do provide a sense of the variability in the ecosystem and should remind us that the environment is not static.

Nelson (1887) reported that sea lions were scarce in the Aleutian Islands in the 1880s, but were abundant in the Pribilof Islands (about 35,000 animals), and during the early 1800s had once numbered several hundred thousand animals on St. George Island alone (but were extirpated upon direction of the Russians). Dixon (1986) investigated middens on Kodiak Islands and found Steller sea lions to be the most common fauna identified. Causey *et al.* (2005) concluded, based on zooarchaeology of early human sites in the Aleutian Islands from *c.* 3500 yr ago, that seabirds have fluctuated with temperature and precipitation. Populations of marine mammals may have also fluctuated (in abundance or availability to Aleuts) based in part on climate and hunting by Aleuts (Dixon 1986, Maschner unpublished manuscript[16]). In reports from expeditions to the Pribilof and Aleutian islands, researchers found Alaskan pollock in the Bering Sea and neighboring waters south to Sitka and the Kurils to be "excessively abundant, swimming near the surface and furnishing the great part of the food of the fur seal" (Jordon and Evermann 1902).

Turner (1886) indicated that Pacific cod and Atka mackerel were apparently rarely encountered at Attu Island prior to 1873, but were abundant there in 1878–81. At Attu Island, capelin were said to be very abundant every third year, as may have been the case at Atka Island. At Atka Island, capelin were also abundant when Turner visited (1878–81), and "dead fish [capelin, post-spawning] were so thick on the beach that it was impossible to walk without stepping on hundreds of them" (Turner 1886, p. 102).

Jordan and Evermann (1902) stated that "Alaskan pollock found in the Bering Sea and neighboring waters south to Sitka and the Kurils. It is excessively abundant throughout the Bering Sea, swimming near the surface and furnishing the great part of the food of the fur seal. It reaches a length of 3 feet and is doubtless a good food-fish." and that "Likewise, cod is very abundant in the Bering Sea", and Atka mackerel is described as being abundant in the Aleutian Islands as it is today and that "Arrowtooth flounder, Greenland turbot, and Pacific halibut were all common." Jordan *et al.* (1896, 1898) in their fur seal accounts state that "In Bering Sea, in August and September, the Alaskan pollock seems to form by far the most important part of the seal's diet" and that "the cod, halibut, and Atka-fish are very abundant."

Alexander (1898a,b) stated that "Cod were abundant…. Their abundance may have been the cause of the seals being plentiful in this region." and that "For several days, seals had been observed chasing some kind of fish….2 seals were speared. The fish proved to be Alaskan pollock. Both seals were large males." Kenyon and Wilke (1952) found "Evidence from the food remains on the Pribilof rookeries is that fur seals depend to a large degree on the…family Gadidae during their stay in the Bering Sea." While Fiscus, Baines and Wilke (1962) found "Theragra, Mallotus and squid have consistently been the principal food of seals in the Bering Sea" since observations began in the 19th century (N=thousands).

4.3.12 Summary of Conservation Measures for Steller Sea Lions

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[16] From Maschner, H.D.G, K. Reedy-Maschner, A.M. Tews, and M. Livingston. Unpublished manuscript. Anthropological investigations on the decline of the Steller sea lion in the western Gulf of Alaska and southern Bering Sea.

This section describes the conservation measures that have been undertaken to reduce impacts to Steller sea lions. These measures are part of the environmental baseline. Most of the actions have been focused on the western DPS while some have broader implications.

The incidental take of Steller sea lions in fishing gear and the shooting of sea lions by fisherman and others were factors in the decline during the 1970s and 1980s. However, by the early 1990s, laws implemented under the Marine Mammal Protection Act (MMPA), ESA, and MSFCMA had reduced these levels to negligible amounts. From the mid-1990s to the present, conservation efforts have focused largely on federal fishery restrictions, disturbance issues, and subsistence harvests. Although actions to reduce intentional take have been effective, it is unknown whether fishery conservation measures have been effective in reducing threats to Steller sea lions. Nevertheless, moderating declines and recent population increases following these measures has resulted in debates about cause and effect. Unlike the direct take of a species, indirect take through competitive interactions is difficult to either prove or disprove with currently available data. The increasing sea lion population trend is correlated with fishery conservation measures taken since the 1990s, but it is unknown whether the relationship is causal (Hennen 2006).

4.3.12.1 Reduction of Intentional and Illegal Killing

Prior to 1972, approximately 45,000 Steller sea lions were intentionally killed in Alaska during state-sanctioned commercial harvest and predator control programs (Merrick et al. 1987). A large but unknown number of Steller sea lions are believed to have been shot throughout the state between 1972 and 1990 (Trites and Larkin 1992).

These sources of direct intentional killing of Steller sea lions were banned following passage of MMPA in 1972. A provision under section 118 of the MMPA, however, allowed fishermen to lethally deter Steller sea lions from interfering with commercial fishing operations. The provision allowing lethal deterrence was eliminated in 1990 when sea lions were listed as threatened under the ESA. Following this protection, both NOAA and fishing industry representatives supported a "Don't Shoot Sea Lions" campaign and two cases of illegal shootings were successfully prosecuted in 1998. Increased public scrutiny and the threat of fishery closures curbed illegal killings, and the current level of illegal shooting is believed to be minimal (Angliss and Outlaw 2002).

Because it is illegal, intentional killing of Steller sea lions is rarely observed, and no formal reports of lethal deterrence in commercial fisheries have been recorded by fishermen or observers since the practice was banned. The two convictions cited above however resulted from confidential voluntary reports from commercial fishermen who witnessed and reported the violations to NMFS Enforcement agents.

Systematic surveys of shorelines have successfully located carcasses of gunshot Steller sea lions (Wynne 1990). In areas where subsistence hunting occurs, it is impossible to determine whether the gunshot sea lions were shot illegally or legally, in a subsistence harvest, and subsequently lost.

4.3.12.2 Reduction of Incidental Takes in Commercial Fisheries

Steller sea lions have been incidentally caught in a variety of commercial fishing gear including gillnets (Wynne 1990), trawls (Loughlin and DeLong 1983), and longlines (Angliss and Outlaw 2005). Steller sea lions may also ingest baited hooks set for salmon by commercial or recreational trollers (Angliss and Outlaw 2005). The frequency of lethal entanglements varies annually, by gear type and method, but the minimum estimate between 1996 and 2000 averaged 29.5 animals a year (Angliss and Outlaw 2005) and was 30.5 and 3.6 in 2005 for the western and eastern DPSs respectively (Angliss and Outlaw 2005).

The MMPA authorized the incidental take (serious injury and death) of marine mammals in the course of commercial fishing operations while striving to reduce that mortality to an insignificant level. The MMPA was amended in 1988 to better monitor the cumulative effects of fishery-specific incidental takes. As a result, each US fishery is designated as being in one of three categories based on its frequency of marine mammal interaction; this "List of Fisheries" is reviewed annually. Vessel owners in Category I or II fisheries (frequent or occasional interactions) are required to register with the NMFS Marine Mammal Authorization Program and to record all lethal marine mammal interactions. The 1988 amendments also required the Secretary to implement emergency regulations to prevent further taking of Steller sea lions if more than 1,350 were taken during a calendar year.

In addition, NMFS may place observers on Category I and II vessels to 1) obtain reliable estimates of incidental serious injury and mortality of marine mammals; 2) determine the reliability of reports submitted by vessel owners and operators; 3) identify changes in fishing methods or technology that may decrease incidental serious injury or mortality if necessary; 4) collect biological samples that may otherwise be unobtainable for scientific studies; and 5) record data on bycatch and discard levels of all species.

The 1994 amendments to the MMPA presented a new means of identifying and weighing the cumulative anthropogenic threats to each marine mammal stock and a process for reducing fishery-specific impacts. For each stock, a Potential Biological Removal (PBR) level is calculated that represents the annual human-induced mortality the stock can sustain, based on conservative estimates of minimum population level and net productivity and then reduced by a scaled recovery factor (Angliss and Outlaw 2005). Total annual human-related mortality is then compared to PBR to determine "Strategic Stocks" and identify those fisheries for which incidental take must be reduced. If incidental mortality of a stock in commercial fisheries exceeds PBR, NMFS is required to convene a Take Reduction Team and develop a Take Reduction Plan to reduce the level of incidental fishing-related mortality. Although the western stock of Steller sea lions is considered "strategic," the current level of incidental take is lower than the PBR; no Take Reduction Team has been convened for either stock.

Observer programs already collecting catch data under provisions of the MSFCMA in Category I fisheries were assigned the additional task of reporting incidental marine mammal take in those fisheries. Under this program, incidental take of Steller sea lions is monitored by NMFS observers on 33-76% of groundfish trawl vessels fishing in AK, WA, OR, and CA (Angliss and Outlaw 2005).

For Category I and II state fisheries, NMFS developed a Marine Mammal Observer Program under the MMPA mandates. The Alaska Marine Mammal Observer Program has monitored the incidental take of Steller sea lions and other marine mammals and birds in state-managed set and drift gillnet fisheries for salmon occurring in Prince William Sound, S. Alaska Peninsula, Cook Inlet, and Kodiak. Observers continue to document the incidental take of Steller sea lions from the eastern DPS occurring in the CA/OR thresher shark and swordfish drift gillnet and Northern WA set gillnet fishery. Updated information on incidental fishing-related mortality is incorporated into annual NMFS reviews of the status of marine mammal stocks, including Steller sea lions.

4.3.12.3 Subsistence Takes

Alaska Natives were exempted from the 1972 MMPA and ESA ban on taking marine mammals. This exemption allowed Alaska Natives to continue taking marine mammals for subsistence or handicraft purposes. The mean annual harvest of Steller sea lions (including struck and lost – those animals killed but not recovered) by Alaska Natives for 2000 - 2004 was estimated by the subsistence division of the Alaska Dept. of Fish & Game to be 190.4 (Angliss and Outlaw 2005).

In 1994, section 119 of the MMPA was amended to allow for the co management of marine mammal stocks used for subsistence purposes by Alaska Natives. Co-management provides a mechanism for NMFS to work with Alaskan Native Organizations (ANO) to manage use of marine mammal species listed under the ESA and to participate in research efforts. For example, the Tribal Government of St. Paul and the Aleut Community of St. George located in the Pribilof Islands, have each signed co-management agreements with NMFS for Steller sea lions.

The Tribal Governments of St. Paul and of St. George each monitor sea lion subsistence harvest as a function of the co-management agreement in place, and provide harvest information to NMFS. The Tribal Government of St. Paul has implemented a real-time harvest monitoring method to increase the accuracy in reporting. This method is also being adopted on St. George in 2005. Annual estimation of harvest, including those struck-and-lost, for other ANOs, is not available.

4.3.12.4 Reduction in Research-related mortality

Intentional lethal sampling of Steller sea lions was a primary means of collecting reproductive, morphometric, dietary, and histologic samples for scientific research in the 1960s and 1970s. This sampling method was strictly regulated after passage of the MMPA and was discontinued once the species was listed as Threatened under the ESA.

Activities authorized under the MMPA and ESA are highly regulated and closely monitored and may include the incidental taking or harassment of Steller sea lions in the course of bonafide research. These research activities, including counting, capturing, and handling animals, may result in inadvertent or indirect Steller sea lion mortality.

Efforts are underway to reduce the amount of disturbance on rookeries caused by the presence of researchers for the purpose of counting. Aerial surveys may serve as an alternative to some of the work currently necessitating human presence.

The NMFS Permit office reviews permit applications, which are also reviewed by the Marine Mammal Commission and made available for public review through notice in the Federal Register. Researchers are required to submit annual plans and reports of research activities and real-time reports of research-related mortality. Cumulative impacts of multiple projects are monitored by a Regional Coordinator, and all research may be curtailed if incidental mortalities reach a pre-determined cap.

4.3.12.5 Pollution, Contaminants, and Entanglement in Marine Debris

Steller sea lions are exposed to local and system-wide contaminants and pollutants as they traverse the North Pacific basin. Effects on other pinnipeds have included acute mortality, reduced pregnancy rates, immuno-suppression, and reduced survival of first born pups (see Section III), but there have been no published reports of contaminants or pollutants representing a mortality source for Steller sea lions.

Steller sea lions have been observed with packing bands, discarded netting, and other debris around their necks. Such debris can be lethal if the debris is not degradable. Annex V of the MARPOL Treaty bans the dumping of plastic trash in the ocean or navigable waters of the U.S. (outside 3 nm from shore). Information and education combined with voluntary community-based efforts have resulted in the retrieval, recovery, and disposal of discarded nets and gear in several fishing areas (e.g. Oregon, St. Paul Island, Puget Sound).

Researchers record the frequency and type of debris observed on Steller sea lions during resight surveys and, infrequently, the relative amount and type of debris seen on haulouts and rookeries they visit.

4.3.12.6 Reduction in Disturbance on Terrestrial Sites and Critical Habitat

Disturbance of Steller sea lion haulouts and rookeries can potentially cause disruption of reproduction, stampeding, or increased exposure to predation by marine predators. Terrestrial habitat has been protected throughout the range by a variety of agencies, and by the fact that sea lions generally inhabit remote, unpopulated areas. Many haulouts and rookeries used by the western DPS are afforded protection from disturbance because they are located on land whose access is regulated by the Alaska Maritime National Wildlife Refuge and other agencies.

No transit zones for vessels within 3 nm of listed rookeries were implemented under the ESA during the initial listing of the species as threatened under the ESA in 1990. These 3 nm buffer zones around all Steller sea lion rookeries west of 150°W were designed to prevent shooting of sea lions at rookeries. Today, these measures are important in protecting sensitive rookeries in the western DPS from disturbance from vessel traffic. In addition, NMFS has provided

"Guidelines for Approaching Marine Mammals" that discourage approaching any closer than 100 yards to sea lion haulouts.

Since the listing of Steller sea lions in 1990, NMFS has commented on hundreds of federal actions through the informal consultation process. NMFS commonly consults informally with the US Forest Service on logging projects, with the EPA on discharge permits, and with the Minerals Management Service on oil and gas lease sites. NMFS comments on actions that may take place in sensitive Steller sea lion critical habitat and suggests means to avoid the most sensitive areas or minimize the likelihood of having adverse impacts.

In 2002, NMFS implemented the North Pacific Fishery Management Council (NPFMC) recommendation to require a Vessel Monitoring System (VMS) on federally licensed groundfish vessels involved in pollock, cod and Atka mackerel fisheries. The VMS tracks fishing vessels, providing real-time information on vessel location and violation of no-transit and no-trawl areas.

4.3.12.7 Fishery Measures

Steller sea lions prey upon some fish species that are also harvested by commercial, subsistence, and recreational fisheries (e.g. pollock, Pacific cod, Atka mackerel, salmon, and herring). Fishery removals have the potential to reduce the availability of these species to sea lions at a variety of spatial and temporal scales (NMFS 2000, 2001). Reduced prey availability can represent an acute or chronic threat to sea lion populations (Trites and Donnelly 2003). Acute prey shortages may lead to starvation while chronic (or sub-lethal) prey shortages have been shown in other mammals to reduce reproductive fitness, increase offspring mortality, and increase the susceptibility to disease and predation.

Immediately after listing in the early to mid-1990s, NMFS implemented a number of conservation measures intended to ensure that commercial harvests of pollock, Pacific cod, and Atka mackerel would not limit the recovery of Steller sea lions (Ferrero *et al.* 1994, Fritz *et al.* 1995). In addition to those direct actions, many other fishery management measures recommended by the NPFMC and implemented by NMFS may have indirectly contributed to Steller sea lion conservation efforts (see below for a detailed list of actions).

In the late 1990s and early 2000s, NMFS reviewed federally managed groundfish fisheries in a series of consultations under section 7 of the ESA. Two of those consultations resulted in a determination that the commercial fisheries were likely to jeopardize the continued existence of the western DPS of Steller sea lion and adversely modify its critical habitat. Therefore, as required under the ESA, additional conservation measures were implemented to avoid jeopardy and adverse modification (NMFS 1998a, NMFS 2000). The expectation was that these measures would promote the recovery of Steller sea lions in areas where potential competition from commercial fisheries may have contributed to the population decline.

The implementation of conservation measures, in both the early 1990s and the late 1990s early 2000s, is correlated with a reduction in the rate of decline of the western DPS of sea lions.

However, the information necessary to determine if the conservation measures actually contributed to the reduced rate of decline is not currently available.

A suite of fishery conservation measures was implemented in 2002 after being reviewed under an ESA section 7 consultation (NMFS 2001). These measures are described in detail in the 2001 Biological Opinion (NMFS 2001) and its Supplement (NMFS 2003). The measures were intended to reduce fishing in near-shore critical habitat, reduce seasonal competition for prey during critical winter months, and disperse fisheries spatially and temporally to avoid local depletions of prey.

The 2002 measures provided increased protection for near-shore critical habitat areas based on an analysis that closely examined satellite telemetry data and on information on foraging behavior, diet, nutritional stress, and population distribution. The analysis placed increased importance on near-shore critical habitat, specifically identifying those areas within 0-10 nm of listed haulouts and rookeries as more important for foraging sea lions than waters from 10-20 nm offshore.

NMFS (2003), re-evaluated each of the conservation measures after they had been implemented in 2002 and concluded that despite various levels of effectiveness in achieving specific goals, the conservation measures were, in aggregate, successful in avoiding jeopardy and adverse modification of critical habitat. A summary table of the effectiveness of each of the actions can be found in Table IV-1 of NMFS (2003). NMFS (2003) provides an in-depth review of each of the conservation measures, a review of the satellite telemetry data (available at the time), and an analysis of the important foraging areas for sea lions based on those data. Further, a summary of the federal fishery management measures that may have affected Steller sea lions is provided in NPFMC (2005a, 2005b) and described in this opinion in Chapter 2.

The following is a compilation of the conservation measures implemented by NMFS since the development of the BSAI and GOA FMPs. Further description of conservation actions are provided in Section 2.5.2. Biological opinions are described in Section 1.2.

1. In 1989, the Environmental Defense Fund and 17 other environmental organizations petitioned NMFS for an emergency rule listing all populations of Steller sea lions in Alaska as endangered and to initiate a rulemaking to make that emergency listing permanent.
2. On April 5, 1990, NMFS issued an emergency interim rule (55 FR 12645) to list the Steller sea lion as a threatened species under the ESA and established protective regulations as emergency interim measures to begin the recovery process. The rule established the following:
   - Monitoring of incidental take and monthly estimates of the level of incidental kill of Steller sea lions in observed fisheries.
   - Aggressive enforcement of protective regulations, especially as they relate to intentional, lethal takes of Steller sea lions.
   - Establishment of a Recovery Team to provide recommendations on further conservation measures.

- Prohibition of shooting at or within 100 yds of Steller sea lions (this did not apply to Alaska native subsistence hunting).
- Establishment of 3 nm “no-approach” buffer zones around the principle Steller sea lion rookeries in the GOA and Aleutian Islands.
- Reduction of incidental kill quota from 1,350 to no more than 675 Steller sea lions.

3. On November 26, 1990, NMFS issued the final rule to list the Steller sea lion as threatened under the ESA (55 FR 49204).
4. On January 7, 1991, NMFS issued a final rule to implement regulations to amend the BSAI and GOA FMPs that limited pollock roe-stripping and seasonally allocated the pollock TAC in the BSAI and GOA (56 FR 492). For BSAI fisheries, the pollock TAC was divided between an A (roe) season and a B season (summer-fall). In the GOA fisheries, the pollock TAC for the Central and Western (C/W) Regulatory areas was divided into 4 equal seasons. NMFS noted in the proposed rule (55 FR 37907, September 14, 1990) that “shifting fishing effort to later in the year may reduce competition for pollock between the fishery and Steller sea lions whose populations have been declining in recent years.”
5. On June 19, 1991, NMFS issued an emergency interim rule to ensure that pollock fishing did not jeopardize the continued existence or recovery of the threatened Steller sea lion (56 FR 28112). The rule contained the following measures to protect Steller sea lions:

   - Allocated the pollock TAC for the combined W/C Regulatory areas equally between two subareas located east and west of 154°W,
   - Limited the amount of unharvested pollock TAC that may be rolled over to subsequent quarters in a fishing year, and
   - Prohibited fishing with trawl gear in the EEZ within 10 nm of 14 Steller sea lion rookeries.

6. On January 23, 1992, NMFS issued a final rule to implement amendments 20/25 to the BSAI and GOA FMPs (57 FR 2683). This replaced prior emergency rules, and extended some of the protections. The amendments contained the following protections:

   - Prohibited trawling year-round within 10 nm of 37 Steller sea lion rookeries in the GOA and BSAI,
   - Expanded the no-trawl zone to 20 nm for 5 of these rookeries from January 1 through April 15 each year,
   - Established 3 GOA pollock management districts, and
   - Imposed a limit on the amount of an excess pollock seasonal harvest that may be taken in a quarter in each district.

7. On January 7, 1993 NMFS released the final Steller sea lion Recovery Plan. Section 4(f) of the ESA requires that NMFS develop and implement plans for the conservation and survival of endangered and threatened species. NMFS appointed a Steller Sea Lion Recovery Team to draft the Recovery Plan in 1990. The draft Recovery Plan was released for public review and comment on March 15, 1991. NMFS responded to comments received and provided notice on January 7, 1993 that the final Recovery Plan was available (58 FR 3008).
8. On March 12, 1993, NMFS issued a final rule to implement a seasonally expanded no-trawl zone around the Ugamak Island Steller sea lion rookery in the eastern Aleutian Islands during the pollock roe fishery season in the BSAI (58 FR 13561). The expanded buffer zone around Ugamak Island was expected to better encompass Steller sea lion winter habitats and juvenile foraging areas in this portion of the southeastern Bering Sea shelf during the BSAI winter pollock fishery.
9. On July 13, 1993, NMFS issued a final rule to implement regulations (BSAI FMP amendment 28) that subdivided the Aleutian Islands subdistrict into three subareas (Areas 541, 542, 543) (58 FR 37660). This action was taken because of concerns that concentrated fishery removals, particularly Atka mackerel, in the eastern Aleutian Islands could cause localized depletions. While dispersal of the Atka mackerel TAC was initiated to conserve fishery resources, it was also consistent with the conservation objectives for Steller sea lions.
10. On August 27, 1993, pursuant to the ESA (§1533(a)(3)(A)), NMFS designated critical habitat for Steller sea lions (58 FR 45269).
11. On November 1, 1993, NMFS initiated a status review of Steller sea lions to determine whether a change in classification to endangered was warranted (58 FR 58318). NMFS solicited comments and biological information concerning the status of Steller sea lions to be used in its review.
12. On November 29-30, 1994, NMFS convened the Steller Sea Lion Recovery Team specifically to consider the appropriate ESA listing status for Steller sea lions and to evaluate the adequacy of ongoing research and management programs. The Recovery Team recommended that NMFS list the Steller sea lion as two separate population segments, split to the east and west of 144°W. The Recovery Team recommended that the western population segment be listed as endangered and the eastern population segment be listed as threatened.
13. In October 1995, NMFS issued a proposed rule to list the western population of the Steller sea lion as endangered.
14. On May 5, 1997, NMFS reclassified Steller sea lions as two distinct population segments under the ESA (62 FR 24345). The population segment west of 144°W (near Cape Suckling, AK) was reclassified as endangered, while the population east of 144°W was maintained as threatened.
15. On March 17, 1998, NMFS issued regulations to create a separate forage fish category (Amendments 36/39 to the BSAI and GOA FMPs; 63 FR 13009). Directed fishing for

forage fish was prohibited at all times in Federal waters of the BSAI and GOA. The intended effect of this action was to prevent the development of a commercial directed fishery for forage fish, a critical food source for many marine mammal, seabird, and fish species.

16. On June 11, 1998, NMFS issued a final rule to reallocate pollock TAC in the W/C Regulatory areas of the GOA by moving 10% of the TAC from the 3rd fishing season, which started on September 1, to the 2nd fishing season, which started on June 1 (63 FR 31939). This seasonal TAC shift was a precautionary measure intended to reduce the potential impacts on Steller sea lions.
17. On January 22, 1999, NMFS issued a final rule to spatially and temporally distribute the Atka mackerel TAC in the Aleutian Islands subarea. This was a precautionary approach to reduce the probability of localized depletions of Atka mackerel inside Steller sea lion critical habitat. The amendment implemented both spatial and temporal redistribution of the Atka mackerel TAC.
18. On January 22, 1999, NMFS published an emergency interim rule (64 FR 3437) implementing the reasonable and prudent alternatives (RPAs) from the December 3, 1998 Biological Opinion which concluded that the pollock fisheries as proposed were likely to jeopardize the continued existence of the endangered western population of Steller sea lions and adversely modify its critical habitat. The rule created (1) temporal dispersion of fishing effort, (2) spatial dispersion of fishing effort, and (3) pollock trawl exclusion zones around Steller sea lion rookeries and haulouts. On July 21, 1999, NMFS extended the emergency rule through December 31, 1999 (64 FR 39087), with revisions to include specifications for the B and C pollock seasons in the Bering Sea.
19. In October 1999, NMFS conducted additional analyses of the RPAs and developed revised final RPAs (RFRPAs) to be incorporated into the December 3, 1998 Opinion as compelled by a Court Order. The RFRPAs provided a detailed set of alternative management measures that would avoid the likelihood that the pollock fisheries would jeopardize the continued existence of the western population of Steller sea lions or adversely modify its critical habitat. Season dates, pollock catch percentages within critical habitat, and no pollock trawling areas were modified from the original RPAs.
20. On January 25, 2000, NMFS published an emergency interim rule (65 FR 3892) implementing the RFRPAs from the December 3, 1998, Biological Opinion as modified in October 1999. On June 12, 2000, NMFS extended the emergency interim rule through December 31, 2000 (65 FR 36795).
21. On August 9, 2000, NMFS closed all Steller sea lion critical habitat to all groundfish trawling to comply with a U.S. District Court Order (65 FR 49766, August 15, 2000).
22. On November 30, 2000, NMFS issued a biological opinion on the FMPs (comprehensive BiOp), which determined that the pollock, Pacific cod, and Atka mackerel fisheries were likely to jeopardize the continued existence of the western DPS of Steller sea lions and to adversely modify its critical habitat. It contained a reasonable and prudent alternative (RPA) that included large fishery closure areas, harvest limits and seasonal distribution of harvest for the pollock, Pacific cod, and Atka mackerel fisheries. Before the RPA could be implemented, the President signed Public Law 106–

554 on December 21, 2000, which contained a 1–year timetable to phase in the RPA. This year provided the Council with time to develop alternative conservation measures that would avoid jeopardy and adverse modification of critical habitat for Steller sea lions.

23. On January 1, 2001, in accordance with Public Law 106–554, the 2001 BSAI and GOA groundfish fisheries were initially managed in accordance with the fishery management plans and Federal regulations in effect for such fisheries prior to July 15, 2000 (i.e., prior to the trawling ban in critical habitat, thus lifting the prohibition).
24. On January 22, 2001 NMFS published an emergency interim rule (66 FR 7276) under the Magnuson-Stevens Act which replaced the initial fishery management regime of 2001 as provided in Public Law 106–554, section 209(c)(4), effective on January 18, 2001 (and corrected and amended March 20, 2001 (66 FR 15656), March 29, 2001 (66 FR 17083 and 17087), July 2, 2001 (66 FR 34852), July 17, 2001 (66 FR 37167) August 22, 2001 (66 FR 44073), and September 20, 2001 (66 FR 48371)). The emergency interim rules contained a suite of management measures that phased in certain provisions of the RPA from the 2000 Biological Opinion. The July 17, 2001 emergency interim rule implemented the Steller sea lion protection measures that were developed by the Council's RPA Committee and forwarded to NMFS for review and implementation.
25. In July 2001, the parties to the litigation concerning the biological opinions and the RFRPA (1998 Biological Opinion and subsequent October 1999 revision) filed a joint status report and agreed to stay further litigation until completion of the 2001 BiOp in October 2001. A subsequent joint status report dated November 1, 2001, agreed to continue the temporary stay of litigation until January 18, 2002, when a follow-up status report would be filed with the Court.
26. In October 2001, NMFS issued a biological opinion in (2001 BiOp), which determined that the Steller sea lion protection measures developed by the RPA Committee and the Council were unlikely to jeopardize the continued existence of the western DPS of Steller sea lions or adversely modify its critical habitat. These measures were implemented by emergency interim rule (67 FR 956, January 8, 2002, amended and corrected 67 FR 21600, May 1, 2002, and extended 67 FR 34860, May 16, 2002 and corrected July 10, July 19, and October 18, 2002 (67 FR 45671, 47472, and 64315, respectively).
27. On January 2, 2003 NMFS issued a final rule (68 FR 204), which implemented the Steller sea lion protection measures reviewed in the 2001 BiOp (and corrected May 8, 2003 (68 FR 24615)).
28. To ensure consistency with State closures (Alaska State waters) for Steller sea lion protection measures in the Pacific cod pot fishery, NMFS removed restrictions on using pot gear for directed fishing for Pacific cod by vessels named on a Federal groundfish fishing permit in waters within 3 nm of Cape Barnabas and Caton Island (May 28, 2003, 68 FR 31629).
29. On December 20, 2004, NMFS issued a final rule (69 FR 75865) which implemented changes to the Steller sea lion protection measures in the GOA for the pollock and

Pacific cod fisheries. The final rule adjusted Pacific cod and pollock fishing closure areas near four Steller sea lion haulouts and modified the seasonal management of pollock harvest in the GOA. The intent of the revisions was to maintain protection for Steller sea lions and their critical habitat while easing the economic burden on GOA fishing communities.

30. March 2008 NMFS finalized the revised Recovery Plan for the Eastern and Western Distinct Population Segments of Steller Sea Lion.

4.4 Direct and Indirect Impacts of Commercial Fisheries Within the Action Area

The BS, AI, and GOA contain some of the most productive waters on earth. The continental shelf in the eastern Bering Sea is broad and supports large, standing stocks of groundfish. The GOA has a much narrower shelf and supports a smaller standing stock than the BS. The Aleutian Islands has a very narrow shelf with deep drop offs within 5-20 nm from shore and has recently been highlighted as a very unique and potentially fragile ecosystem (Ladd *et al.* 2005, Hunt and Stabeno 2005, Stabeno *et al.* 2005). Since the 1950s, a complex international fishery has harvested numerous species; most of the fish harvested in this region are groundfish. The Bering Sea supports about 300 species of fish, most of which live on or near the bottom. About 24 of these species support commercial fisheries in the BSAI and GOA.

Commercial fisheries in the action area have gone through many cycles of development and collapse since they began in the 1800s and the focus of the fisheries has shifted many times since its beginning. A complete historical review of commercial fisheries is provided in NMFS (2000) and incorporated here by reference. Three time periods were outlined:

1. Early commercial fisheries from the 1800s to the 1950s,
2. Large scale growth of fisheries from the 1950s to the 1970s, and
3. Commercial fisheries in the action area from the 1970s to 2000.

These fisheries affected the environment in the BSAI and GOA as described in previous biological opinions (NMFS 2000, 2001, 2003). The following is a discussion of both the direct and indirect effects which are likely to have occurred as a result of commercial fisheries in the BSAI and GOA and a review of ecosystem level impacts.

Management measures to address potential fishery effects on Steller sea lions were first promulgated in 1991 to 1993, and then extensively modified between 1998 and 2002 (Fritz *et al.* 1995, NMFS 2003). The measures included: spatial and temporal allocations of harvest quotas to reduce the likelihood of localized depletions of groundfish prey, fishery exclusion zones to limit spatial overlap between fisheries and sea lions within critical habitat, and modified harvest control rules to reduce the likelihood of overall prey abundance being reduced to less than 20% of pristine levels. NMFS concluded that the proposed suite of management measures (NMFS 2001) and implemented (NMFS 2003) avoided jeopardy and adverse modification of critical habitat. However, since 2003, a substantial quantity of scientific literature on Steller sea lion biology, habitat, and fisheries effects has become available (Loughlin and Tagart 2006) which must be considered in order to evaluate whether the conservation measures remain effective.

Fishing can affect the availability of prey on localized and ecosystem-wide scales (Trites *et al.* 2006e), which is of concern for the stability and recovery of Steller sea lion populations (Lowry *et al.* 1982). Fisheries in Alaska are some of the largest in the world. In 2005, over 2 million metric tons of groundfish were caught in the BSAI and GOA (Tables 2.5 and 2.6), which is equivalent to an overall harvest rate of approximately 10% (Table 3.7 and Figure 4.21). Fishing has the potential to affect Steller sea lion recovery in several ways, including overall ecosystem-wide reductions in prey biomass, local and temporal depletions of prey, and reduced quality (size, age and caloric value) of individual prey by selective removal of larger, older individuals (Goodman *et al.* 2002, Trites *et al.* 2006e). We will assess the direct and indirect (both long term and short term) impacts of fisheries on sea lions and their habitat.

4.4.1 Direct Effects of Commercial Fisheries on Steller Sea Lions and Critical Habitat

Commercial fisheries can directly affect Steller sea lions in the BSAI, and GOA by capturing, injuring, or killing them in fishing gear or in collisions with fishing vessels, and if fishermen kill them intentionally. These impacts were described in detail above in Sections 4.3.3 (incidental take in commercial fisheries), 4.3.4 (intentional and illegal killing), and in 4.3.7 (disturbance). In general, the current level of direct impact to Steller sea lions is relatively small (see summary in Section 4.3.10). However, it is likely that historical direct impacts influenced the rapid decline rate observed in the 1980s, but by the mid-1990s was no longer an important factor in the decline and lack of recovery. Vital rate analyses confirm the reduction in direct mortality (Holmes and York 2003, Holmes *et al.* submitted).

Commercial fisheries in the action area would have affected critical habitat that has been designated for Steller sea lions primarily through the effects on the value of critical habitat to Steller sea lions (discussed under indirect effects below). Critical habitat has not been designated for any other listed species covered by this biological opinion.

4.4.2 Indirect Effects of Commercial Fisheries on Steller Sea Lions

Indirect effects of commercial fishing include social, economic, physical, chemical, and biotic effects. The most notable indirect effect of commercial fisheries on Steller sea lions is the removal of prey species which could alter the animal’s natural foraging patterns and its success rate; both of these effects could have further downstream results such as increased predation risk due to longer or different foraging patterns. Fisheries can also have indirect biological effects that occur when fisheries remove large numbers of target species and non-target species (incidental catch or bycatch) from a marine ecosystem. These removals can change the composition of the fish community with associated effects on the distribution and abundance of prey organisms. Fishery removals compete with other consumers that depend on target organisms for food. These biological effects are generally termed cascade effects and competition. The ultimate impact to sea lions from these types of modification to their prey resources would be either acute or chronic nutritional stress (Trites and Donnelly 2003; see Section 3.1.15).

The survival of large predatory mammals such as Steller sea lions is dependent on the availability of abundant, high quality prey (Stephens and Krebs 1986, Williams 2005a,b; see Section 4.6 below). Due to the high energetic demands of Steller sea lions relative to terrestrial mammals and the large number of sea lions seasonally concentrated on rookeries, this species may be especially vulnerable to reduced prey biomass and quality (Winship and Trites 2003, Williams 2005a). As a result, natural and anthropogenic factors that substantially influence prey availability, particularly during critical life history stages (e.g., pregnant females with a nursing pup, or recently weaned juveniles), have the potential to affect Steller sea lion vital rates and impede their survival and recovery.

A reduction in prey resources may result in a reduction in population growth rate. Specifically, reduced prey availability can lead to physiological responses by sea lions that directly (e.g., reduced natality) or indirectly (e.g., increased mortality from predators due to increased foraging) reduces their population growth. A sustained reduction of prey resources across a broad geographic region (i.e., ecosystem) would thus reduce the carrying capacity of sea lions. These impacts have generally been referred to as nutritional stress.

4.4.2.1 Important Prey Species and Fisheries Which Potentially Affect Sea Lions

Fisheries may compete with sea lions if they remove the same species of fish. Our knowledge of Steller sea lion prey use is largely through the collection and analysis of scat samples and historically through stomach contents (Sinclair and Zeppelin 2002; Table 3.20). In NMFS (2000, 2003), 14 species (or species groups) were of concern in the BSAI and 15 species in the GOA (see Table III-1 in NMFS 2003) to potentially be affected by the federal groundfish fisheries. Sinclair and Zeppelin (2002) assess the importance of various species by area and season. Steller sea lions rely on a variety of prey resources with pollock, Pacific cod, Atka mackerel, salmon, herring, sand lance, and arrowtooth flounder representing the most common species. Sea lions are opportunistic predators which rely on seasonal aggregations of prey resources in predictable locations and quantities (Womble and Sigler 2006, Gende and Sigler 2006).

Steller sea lions eat a wide variety of marine fish and cephalopods, some of which are densely schooled in spawning, migratory, or feeding aggregations (Sinclair and Zeppelin 2002; Table 3.21). The abundances of many of the primary prey species of Steller sea lions have undergone changes during the past 30 years (NRC 1996, 2003, NPFMC 2005a, b). Thus, during the period of decline of Steller sea lion populations in the western DPS, many primary prey species increased in abundance, while others decreased or remained relatively stable (e.g., arrowtooth flounder increased while GOA pollock decreased). Several factors have been implicated in these changes in prey biomass for Steller sea lions: 1) natural or environmental variability, 2) anthropogenic (fisheries) affects, and 3) ecosystem disruption resulting in inter-specific competition (Anderson and Piatt 1999, Trites *et al.* 1999, Benson and Trites 2002). These factors may act individually or collectively to affect the availability of prey for Steller sea lions.

Sea lion diet likely reflects the availability of prey and their ability to take advantage of it (Pitcher 1981, Calkins and Goodwin 1988, NMFS 2000, Sinclair and Zeppelin 2002, Womble and Sigler 2006, Gende and Sigler 2006, Waite and Burkanov 2006). Although we are limited in the locations and times that we have sampled sea lion diets (stomachs or scats), diet likely reflects local availability and vice versa. The Aleutian Islands represent a good example of this foraging pattern. In the Central and Western Aleutian Islands, the average frequency of occurrence of pollock in winter was only 12% while Atka mackerel appears to have been the primary food source for sea lions (found in 55% of scats in winter and 96% in summer; Table 3.21). Sinclair and Zeppelin (2002) point out that although some of the food items had a low frequency of occurrence (FO) when averaged across all samples, some had higher occurrences when looked at during specific seasons or at specific sites (Sinclair and Zeppelin 2002, their Appendix 1). Specifically, areas within the eastern Aleutian Islands seem to be more dependent upon pollock with a FO of 53% in winter. In NMFS (2006c [formal section 7 consultation on AI EFP]; their Table 9), the FO is provided for various haulouts near Adak in the central Aleutian Islands (from Sinclair and Zeppelin 2002; their Appendix 1). Pollock ranked among the top three prey species at both Kasatochi Island (summer) and at Ulak Island (summer), both of which are rookeries in the Central Aleutian Islands. Table 10 (of NMFS 2006c) describes the prey items found in scats at Adak, Amlia, and Kasatochi in 1999 and 2000, and Table 11 (of NMFS 2006c) describes scats at a variety of sites in the central Aleutian Islands since 2001. In general, Atka mackerel was the dominant prey item found, especially during the summer. Pollock was more important in the diet during the winter but was also found at some sites during the summer (NMFS 2006c; Tables 10 and 11, Figure 9). In the most recent samples collected during the winter in 2002, pollock was between 8% and 46% FO at Seguam and Silak (near Adak Island). In these samples pollock was much more important in the diet than the average values reported above and likely represent the local availability of prey as well as the variability in sampling times. Season appears to be an important consideration as pollock was most often in the diet of Steller sea lions during the winter.

NMFS (2006c) concluded:

> *In summary, pollock is an important prey item for Steller sea lions in the Aleutian Islands, especially in the eastern portion of the area and in other locations where pollock may be available in relatively small aggregations, especially in winter. Based on the differences in the occurrence of pollock in scat samples, pollock may be more important to Steller sea lions using the Atka Island/North Cape haulout than for animals using haulouts near Kanaga Sound. The variability of pollock in the diet of sea lions is likely to be linked to the availability of the prey and is likely to reflect similar patterns as the fishery. Harvest of pollock in the Aleutian Islands has been patchily distributed with some locally high harvest amounts due to dense aggregations of pollock nearshore during spawning. Due to the remoteness of the Aleutian Islands, scat is not frequently collected at many sites which further confounds our ability to draw a clear picture of prey utilization in these areas. From the best information available, pollock is likely to be an important component of Steller sea lion diet in the winter but not during the summer (Tables 10 and 11; Sinclair and Zeppelin 2002). Also from the 2001 Opinion, we know that the ratio of prey biomass available to the biomass consumed by sea lions is the lowest in the Aleutian Islands, and may be lower than what is optimal for their survival (NMFS 2003, their Table III-8). This indicates that sea lions in the Aleutian Islands may be more susceptible to perturbations in the prey field than other areas such as the eastern Bering Sea.*

Thus, we cannot assume that average FO over large areas is necessarily a good representation of important prey species at individual haulout sites, or a good representation of the accessibility of the prey field as experienced by sea lions. This is especially true in regions where key prey species may be in relatively low abundance (due to their range). Therefore, although regional trends are important to understand the overall impact of fisheries on subpopulations, it is also important to look at prey needs at smaller scales where the local availability of prey, likely consumption by local sea lions, and the potential for localized depletion may have specific consequences not discernible at larger scales (NRC 2006).

An extensive body of analytical work has been developed on the potential competitive interactions between Steller sea lions and fisheries for pollock, Pacific cod, and Atka mackerel (e.g., Loughlin and Merrick 1989, Ferrero and Fritz 1994, Fritz *et al.* 1995, Fritz and Ferrero 1998, NMFS 2000, Fritz and Brown 2005, Wilson *et al.* 2003, NMFS 2006b). These fisheries were the obvious starting place for analyses of interactions because their target species are the most prevalent items in the diet of Steller sea lions in the GOA and the BSAI (Sinclair and Zeppelin 2002; Table 3.21). However, there are other species targeted (and incidentally caught species) by the Alaska groundfish fisheries in the BSAI and GOA that are also consumed by Steller sea lions. The question of how much overlap actually occurs is highly relevant to determining the exposure of Steller sea lions to fisheries authorized by the State of Alaska and the federal FMPs for groundfish.

NMFS PRD AKR is currently engaged in a re-initiated consultation with NMFS SFD AKR on the fishery management plans for the federally-managed groundfish fisheries in the Bering Sea, Aleutian islands, and Gulf of Alaska and the actions authorized by those plans. The analysis for this consultation is still ongoing and thus results from the analysis are not available for incorporation into the baseline or potential cumulative effects for this consultation.

4.4.2.2 Alaska State Managed Fisheries

Detailed information on fisheries in inside waters is contained in section 4.10 of the Groundfish SEIS, as well as in Kruse *et al.* 2000 and Woodby and Hulbert 2006. This section includes a brief review of those fisheries which may affect Steller sea lions, including:

- A description of the fishery management strategy including any special measures pertaining to sea lions,
- Recent changes in the spatial and temporal distribution of the fisheries, and
- A description of direct and in-direct sea lion interactions.

To this date there have been no studies specifically designed to address the effects of these nearshore fisheries on sea lions, so the information presented here is descriptive in nature. Significant changes in state waters fisheries since the 2001 opinion include an all-time high salmon harvest, the re-opening of several crab fisheries in the GOA, and a new Pacific cod fishery in the Aleutian Islands. This section describes recent changes in state waters including removal of greater volumes of sea lion prey biomass as well as other fish and invertebrate species from nearshore areas. Because the nearshore areas may be more important for sea lions than previously thought in NMFS (2000, 2001), and because some state fisheries are concentrated in time and space critical to sea lions (Woodby and Hulbert 2006), this suggests that state waters fisheries may have greater effects on sea lions than NMFS previously concluded (NMFS 2000, 2001).

ADF&G manages fishing activity occurring inside waters from shore to three miles seaward, herein referred to as state waters. Additionally, ADF&G "exercises varing degrees of management and authority over " BSAI crab, salmon, lingcod, and some rockfish fisheries in Federal waters (EEZ – outside of three miles from shore). With the exception of state managed fisheries that have specified guideline harvest levels (GHLs) for species such as sablefish, Pacific cod, and Prince William Sound pollock, ADF&G coordinates state fishery openings and in-season adjustments with federally managed fisheries (the "parallel" fisheries). For example, when groundfish fishing is open in Federal waters, state regulations allow fishing to occur in state waters in what is referred to as the parallel fishery. The state retains regulatory jurisdiction over all fisheries within state waters.

State fisheries are managed by a highly localized system of regional offices throughout the state by species and area. Each region is responsible for issuing Guideline Harvest Limits (GHL), and providing in-season management of smaller-scale, localized fisheries. This is in contrast to the Federal fisheries which are composed of very large management units with relatively large harvest limits. Whereas the Federal fisheries use summer and winter surveys combined with stock assessment models to assess biomass and catch limits, the state employs a variety of methods of determining catch and biomass including stock recruitment models, aerial surveys, escapement goals, and historical fishery harvest performance. Kruse *et al.* (2000) provide an overview of state managed fisheries that may interact with Steller sea lions, including historical catch, gear used, stock assessment methods, and status of the fish stocks. That information was summarized in the FMP biological opinion (NMFS 2000) and is not repeated here. Woodby and Hulbert (2006) expanded and updated this report to include changes between the 2000 report and the latest fisheries data available before the preparation of this document (2006). They also added information on the Pacific cod, pollock, and Atka mackerel parallel fisheries occurring inside state waters.

Seasonal and temporal distributions of state waters fisheries vary widely by species, area, and gear type, and are discussed in more detail in subsequent sections. These distributions are depicted in detail in Kruse et al 2000 for the year 1999, and in Woodby and Hulbert (2006) for the year 2005. Another descriptive reference is *Commercial Fisheries off Alaska* (Woody et al, 2005). The reader should consult these three references for a complete description of the fisheries. Only summary information is included here.

Direct interactions between state managed fisheries and Steller sea lions involve both lethal and non-lethal impacts. Lethal impacts include sea lions inadvertently killed in fishing gear such as trawls, seines, and gill nets. Non-lethal effects include short term impacts such as disturbance of sea lion haulouts, vessel noise, entanglement in nets, and preclusion from foraging areas due to active fishing vessels and gear. State managed fisheries are estimated to account for the incidental take of about 23 Steller sea lions per year (Angliss and Outlaw 2005). Recently this number has been difficult to verify due to the lack of observer coverage and the expected under-reporting of takes through a voluntary reporting program. On one hand, it might be low due to the lack of observer coverage in these fisheries, yet on the other hand this estimate is potentially biased high due to the very high estimate for a Prince William Sound gillnet fishery (Angliss and Outlaw 2005). There are no available estimates of the frequency or severity of non-lethal takes. Illegal shooting of sea lions by fishermen likely still occurs, but the number of animals affected is difficult to evaluate given the lack of observer coverage on these vessels. Loughlin and York (2001) estimated the mortality level from shooting at 50 sea lions per year, or more.

Potential indirect effects of state managed fisheries include the competition for prey resources and the modification of sea lion critical habitat. State fisheries remove important sea lion prey species, many fisheries are concentrated in space (usually bays or river outlets) and in time (usually spawning aggregations and salmon congregating near rivers for their return to spawning grounds in spring and summer).

The geographic range of state managed fisheries in state waters coincides almost entirely with the area designated as Steller sea lion critical habitat. To reduce interactions between sea lions and state managed fisheries, in 1999 ADF&G established no fishing zones for pollock around most rookeries and a few haulouts out to 3 nm (by Emergency Order, March 17, 1999) and has closed several haulout sites seasonally in Prince William Sound out to 10 nm. Four rookeries designated as critical habitat (Agattu Island/Gillion Point, Agattu Island/Cape Sabak, Wooded Island, and Seal Rocks (Cordova)) were not protected from commercial fishing out to 3 nm by the state emergency order. Four haulouts are included in the March 17, 1999 emergency order because the entire island where a rookery was located is protected by the 3nm fishing closure. These protected haulouts are Seguam Island/Finch Point, Seguam Island/South Side, Kiska/Sobaka and Vega, and Amchitka/Cape Ivakin. The 3 nm closures and 10 nm fishing restricted areas are based upon 1999 federal regulations. Since this time, additional Steller sea lion sites have been added to the regulations at 50 CFR part 679. In 2004, ADF&G mirrored a federal change to open up several sea lion haulouts in the GOA.

In an analysis of Steller sea lion diet, Sinclair and Zeppelin (2002) found that pollock, Atka mackerel, Pacific salmon, Pacific cod, and Pacific herring were consumed in relatively high frequencies by the western stock of sea lions during certain times of the year. Observations from biologists and fishermen indicate spatial and temporal overlap between the state managed fisheries for these species and foraging sea lions (Kruse *et al.* 2000). Information on Steller sea lion foraging patterns suggest that Steller sea lions, and especially pups and juveniles, spend the majority of their time in areas within 10 nm of shore. Because state fisheries are concentrated in time and space in these near shore waters, there is potential for negative effects on sea lion prey (critical habitat) and sea lion condition. Each state waters fishery is unique in its number of participating vessels, gear used, seasonality, duration,
and/or target fish species. The next four sections describe state waters groundfish fisheries, herring fisheries, salmon fisheries, and invertebrate fisheries and their potential effects on sea lions.

State Groundfish Fisheries

State managed groundfish fisheries are relatively small in tonnage compared to the federally managed groundfish fisheries, and are generally confined to specific management areas. The state managed pollock fishery is limited to Prince William Sound, while Pacific cod fisheries occur in Prince William Sound, Cook Inlet, Kodiak, Chignik, and South Alaska Peninsula areas. For a sense of scale, in 2000 the state managed GOA pollock harvest was 1.7% of the federal pollock fishery, and the state managed Pacific cod harvest was 22.5% of the total federal ABC. Parallel fisheries for Pacific cod, pollock, and Atka mackerel are also prosecuted in inside waters prior to the state-managed fisheries seasons, in many of the same locations. Total harvest volume in these fisheries is usually much higher.

In addition to Pacific cod and pollock, the state has established separate GHLs and seasons for the following fisheries in the western GOA: sablefish, lingcod, black rockfish *(Sebastes melanops)*, and blue rockfish *(S. mystinus)*. The state-managed fisheries for sablefish and Pacific cod occur within state waters, whereas the state manages lingcod and black and blue rockfish fisheries throughout the EEZ. In the Central GOA, state-managed fisheries in state waters also include sablefish and all rockfish species in state waters of PWS and lower Cook Inlet (LCI).

The Alaska Board of Fisheries (BOF) created "Guiding Principles for Groundfish Fishery Regulations" (5 AAC 028.89) which stipulate that state groundfish fisheries are managed conservatively to (1) conserve groundfish resources to ensure sustained yield, (2) minimize bycatch and prevent localized depletion of stocks, (3) protect habitat and other associated fish and shellfish, (4) maintain slower harvest rates by methods and means and time and area restrictions, (5) extend the length of fishing seasons by methods and means and time and area restrictions, (6) harvest the resource in a manner that emphasizes quality and value of the product, (7) use the best available information, and (8) manage cooperatively with the North Pacific Fishery Management Council and other federal agencies associated with groundfish fisheries.

These ecosystem-based guiding principles have led to a set of conservation measures for state-managed groundfish fisheries. A number of these management measures provide, directly or indirectly, some protection to Steller sea lions. Substantial areas of state waters are closed to non-pelagic trawling. Most areas are closed year-round, and some areas are closed seasonally as in Shelikof Strait. Moreover, a portion of eastern Prince William Sound is closed to pelagic trawl gear during the pollock fishery (5 AAC 28.263) and most of eastern Prince William Sound is closed to all (non-pelagic and pelagic) trawling year-round (5 AAC 39.165). These trawl closures were established by the BOF to protect seafloor habitats, shellfish such as depressed crab populations, and non-target demersal fishes.

Under the ESA, groundfish fisheries are prohibited within 3 nm around major Steller sea lion rookeries (no-entry zones around major rookeries for all vessels; 50 CFR 223.202). The no-entry zones apply to state permitted fishing vessels as well as federal permitted fishing vessels. The rookery closures are intended primarily to avoid disturbance to rookeries during the breeding season and to maintain a no-disturbance zone year-round to protect these very important breeding sites. The loss of a breeding site to human impacts could have a substantial impact on the population.

Although the 3 nm closures were designed specifically to protect sea lion rookeries, the closures have indirect effects of protecting bottom habitat which provides protection to non-target species including octopus, sculpins, flatfish, greenlings, and other forage fishes. The non-pelagic trawling ban also reduces the possibility of direct cumulative impacts from state managed fisheries on marine habitat and particularly the benthic community.

Walleye pollock

Pollock is harvested in inside waters both in a state-managed fishery in PWS, and in parallel fisheries throughout state waters. The state managed PWS pollock fishery has been declining over the past 6 years. In 2005, most of the harvest occurred in early March inside sea lion critical habitat. The parallel fishery is much larger in volume than the state-managed fishery, and has increased since 2000.

The PWS fishery is based on a constant harvest rate strategy. Because reliable estimates of biomass and natural mortality are available, the PWS pollock stock falls into Tier 5 of the federal stock assessment strategy (see section 2.4.2). The GHL is calculated as the product of the biomass estimate, instantaneous natural mortality rate (0.3) and a “safety factor” of 0.75. Biomass is estimated by bottom trawl surveys in summer and hydroacoustic surveys of spawning aggregations in winter. In 1999 the BOF directed the ADF&G to file an emergency regulation establishing a PWS pollock trawl fishery management plan to reduce potential impacts on the endangered population of Steller sea lions. The plan divides the Inside District of (PWS) into three management sections with no more than 40% of the total harvest coming from any one area (5 AAC 28.263). ADF&G manages to a target of 30% of the total harvest from any one of these areas with a 10% reserve. These spatial management measures may help reduce competition for fish between the pollock fishery and sea lions. This measure was in lieu of closing two Steller sea lion haulouts that were specified to be closed under the 1998 Biological Opinion (NMFS 1998). Although pollock in the GOA are considered to be one stock, the state surveys pollock in PWS separately from NMFS surveys in the GOA. However, NMFS takes the PWS fishery into consideration when setting the GOA TAC.

The effects of the state managed pollock fishery on Steller sea lions is mitigated to some degree by existing restrictions on the fishery. The Prince William Sound outside district (including Wooded Island, Seal Rocks, Cape Hinchinbrook, and Hook Point) is closed to fishing. Since the pollock fishery occurs only in the Prince William Sound inside district, it reduces the potential for removing sea lion prey in the vicinity of critical habitat sites Cape St Elias, Hook Point, Middleton Island, the Wooded Island rookery, and most of the Seal Rock and Cape Hinchinbrook sites. Pollock fishing is prohibited June 1 through November 1 within 10 nm of seven rookeries and haulouts in Prince William Sound (5 AAC 28.250). Two haulout sites within Prince William Sound, Perry Island and Point Eleanor, have no pollock fishing restrictions. The Needles, Point Elrington, and Glacier Island haulouts have no pollock harvest restrictions from November 2 through May 31. The fishery opens Janurary 20 (concurrent with CGOA) and closes by emergency order no later than March 31, 2001.

Steller sea lions using PWS inside district haulouts may experience a depletion of pollock and disruption of the prey field during part or all of the year, and the time period of the pollock fishing restriction does not provide protection during the critical winter months.

The parallel pollock fishery inside state waters in 2005 occurred in Kodiak, Chignik, South Alaska Peninsula, and the Aleutian Islands. The Kodiak fishery peaked in February/March and then again in September/October and occurred throughout all Kodiak statistical areas. The Chignik fishery had landings in January and September and was concentrated south of Chignik at Seal Cape. In the South Alaska Peninsula, most landings occurred in January and October in the Shumagins and Pavlof Bay. The Aleutian Islands fishery landings were highest in July and August, and most harvest was taken at Unalaska Island. These fishery seasons have specific start dates according to the federal pollock fisheries. Most of the A season pollock TAC is taken in January, and then harvest peaks again in early fall when the new season allocation is obtainable. Most of this catch occurs inside sea lion critical habitat in the Kodiak, South Alaska Peninsula, and Aleutian Islands areas. The parallel harvest inside state waters has been between 20 and 40 times the volume of the state-managed PWS fishery in the past 6 years.

Pacific cod

In 1996, the BOF adopted Pacific cod FMPs for fisheries in PWS, Lower Cook Inlet, Chignik, Kodiak, and the South Alaska Peninsula. All five FMPs have some common elements that include: only pot or jig gear is permitted, pot vessels are limited to no more than 60 pots, jig vessels are limited to no more than five jigging machines, and exclusive area registration requirements. Vessels participating in the South Alaska Peninsula and Chignik areas are limited to no more than 58 feet in length. Catches are allocated to users as: 85% pot and 15% jig in South Alaska Peninsula and Chignik areas, 60% pot and 40% jig in PWS, and 50:50 in Kodiak and Cook Inlet areas. If target gear allocation percentages are not met by late in the season, then the unattained GHL becomes available to all gear types. State GHLs are set as a percentage of the federal TAC. State GHLs for PWS are set at 25% of the federal TAC for the eastern GOA. Similarly, up to 25% of the central GOA TAC is allocated among Chignik (up to 8.75%), Kodiak (up to 12.5%) and Cook Inlet (up to 3.75%). Finally, the state GHL for the South Alaska Peninsula fishery is set at 25% of the western GOA TAC. The fishery generally occurs in the spring following the Federal fishery, opening by regulation between 1 and 7 days after the federal fishery closes.

Pacific cod harvested in state waters in 2005 came from sea lion critical habitat in the South Alaska Peninsula (most harvest occurring in March), Kodiak (February through April), and Chignik (March through May) areas primarily, with smaller harvests in PWS and Cook Inlet. The temporal distribution of catch around Kodiak was more concentrated in 2005 from February through April as compared to 1999 when there was a more substantial fall component to the harvest.

In addition to the state managed fishery, the parallel Pacific cod fishery also occurs inside state waters and mostly inside sea lion critical habitat. In PWS, the 2005 parallel fishery was much more widely distributed than the state-managed fishery and most harvest was taken in April and August. A greater volume of Pacific cod was taken in the parallel fishery in Cook inlet in February and March and extends all along the outer coast from Resurrection Bay to the tip of the peninsula. The Kodiak parallel fishery was about equal in volume and spatial distribution to the state-managed fishery, but was mostly taken in January and late fall. A similar pattern emerges in the South Alaska Peninsula fisheries with most parallel harvest taken in January and February. The Chignik fisheries break this pattern in that the parallel fishery is very small in comparison to the state-managed fishery. There was no state-managed fishery for Pacific cod in the Aleutian Islands in 2005. The parallel fishery was spread along the chain and harvested most catch from February to April.

On March 15, 2006, the BOF approved the opening of a new state waters Pacific cod fishery in the Aleutian Islands west of 170W for pot, jig, longline, and non-pelagic trawl gears. This state-managed fishery opens after the parallel fishery closes. The 2005 GHL was 5807 mt, or 3% of the BSAI ABC. The fishery is temporally regulated so that no more than 70% of the GHL can be harvested before June 10, 2006, however, most of this was taken in March. The remainder of the GHL can be harvested starting June 10. Twenty-six vessels registered for the fishery, including 3 trawlers less than 60 feet, 17 larger trawlers, one large pot vessel, 5 large freezer longliners, 2 floating processors and 2 shore-based processors participated. Observer coverage and VMS are not required in this state-waters fishery, but 6 vessels chose to carry a federal observer, and 23 planned to activate VMS during the fishery.

Atka Mackerel

There is no state-managed fishery for Atka mackerel other than the parallel fishery that occurs inside state waters. The parallel Atka mackerel fishery is harvested with bottom trawl gear and has ranged between 12 and 88 mt from 2000 to 2005 (Woodby and Hulbert 2006). Because most state waters are closed to bottom trawling and Atka mackerel generally do not occur in the GOA, this fishery is largely confined to a few small locations in the Aleutian Islands, including Unalaska Island, Atka island, and the Islands of Four Mountains. These areas are inside sea lion critical habitat. Most landings occurred in June and August in 2005.

Other Groundfish

Sablefish, rockfish, and lingcod are not important in the diet of Steller sea lions, but fisheries for these species could cause indirect impacts to sea lion foraging behavior through disturbance. There are no specific measures to protect sea lions included in the state management plans for these species. Sablefish landings occurred inside sea lion critical habitat in PWS, lower Cook Inlet, and the western Aleutian islands in 2005. Landings occurred in March through May and August in PWS, in July in Cook inlet, and primarily May through August in the western Aleutian Islands. Most of the lingcod harvest in 2005 was taken in the Kodiak area, although catch occurred inside sea lion critical habitat in Kodiak, Cook Inlet, and PWS from July through October. Similarly, most rockfish harvest occurred around Kodiak Island, but harvest occurred inside sea lion critical habitat in PWS, Cook Inlet, Kodiak, Chignik, South Alaska Peninsula, and the Aleutian Islands primarily from March through August.

Harvest of Steller Sea Lion Prey Species

The amount of groundfish prey species (pollock, Pacific cod, and Atka mackerel) harvested in the parallel fisheries is presented in Table 4.7. Although the amount of fish harvested in the 3 nm area around haulouts appears low, the amount of area composed inside 3 nm of haulouts in the GOA is roughly 0.5% of the total area. Catch percentages of up to 7.4% of total (pot, Pacific cod) represent a catch rate that is two orders of magnitude higher than a theoretically dispersed fishery. Again, the type of data necessary to evaluate whether this may or may not be a problem is lacking, such as information on biomass availability on small scales. Further complicating matters, the fleet fishing within state waters during these parallel seasons are generally small unobserved vessels. Because of this, very limited information is available on these fishing activities as compared to larger boats operating in federally managed waters that have observer coverage.

State Herring Fisheries

At present, state herring fisheries that occur within sea lion critical habitat include fisheries in Prince William Sound, Cook Inlet, Kodiak, Alaska Peninsula, Bristol Bay, Kuskokwim, Norton Sound, Southeast, and Port Clarence. Approximately 25 distinct fisheries for Pacific herring occur in these regions. Harvest methods are by gillnet, purse seine, and handpicking of roe from kelp. Herring are primarily caught for their roe during the sac roe harvest in the spring when they move closer to shore (and therefore sea lion critical habitat) to spawn. On occasion the entire allowable harvest has been taken in less than one hour, although most sac roe fisheries occur during a series of short openings of a few hours each, spanning approximately one week. Fishing is not allowed between these short openings to allow processors time to process the catch, and for managers to locate additional herring of marketable quality.

Prior to 1999, the average annual harvest of herring for sac roe was about 48,000 mt. During the past 5 years, harvest of herring for sac roe has been stable at around 22,000 mt. due to low abundance in some areas. The major populations of herring in Alaska are at moderate levels and in relatively stable condition, with the exceptions of Prince William Sound and Cook Inlet. Since 1999, the PWS fishery has been closed due to low abundance, and in 2006 the Exxon Valdez Oil Spill Trustee Council initiated planning for a long-term herring restoration program. The lower Cook Inlet fishery has been closed since 1998 due to low abundance. Herring harvest near Kodiak has increased during the last 6 years and is distributed throughout sea lion critical habitat. The fishery occurs in a concentrated time period from late April to early May.

Spawn-on-kelp fisheries harvest intertidal and subtidal macroalgae which contain freshly deposited herring eggs. Smaller amounts of herring are harvested from late July through

February in herring food/bait fisheries. Herring spawn timing is temperature dependent, so that herring spawning and roe harvest timing occurs progressively later from southeast Alaska, where spawning begins in March, through the northern Bering Sea, where spawning ends in June. Herring food and bait landings in 2005 in the Alaska peninsula area were concentrated in the Akutan district inside sea lion critical habitat and occurred in late July. Smaller food and bait landings occurred in Kodiak in January, October, and December of 2005.

Harvest policies used for herring in Alaska set the maximum exploitation rate at 20% of the exploitable or mature biomass. The 20% exploitation rate is considered by ADF&G to be lower than commonly used biological reference points for species with similar life history characteristics. In some areas, such as Southeast Alaska, a formal policy exists for reducing the exploitation rate as the biomass drops to low levels. In other areas, the exploitation rate is similarly reduced, without a formal policy. In addition to exploitation rate constraints, minimum threshold biomass levels are set for most Alaskan herring fisheries. If the spawning biomass is estimated to be below the threshold level, no commercial fishing is allowed. Threshold levels are generally set at 25% of the long-term average of unfished biomass (Funk and Rowell 1995).

Most herring fisheries in Alaska are regulated by management units or regulatory stocks (i.e., geographically distinct spawning aggregations defined by regulation). Those aggregations may occupy areas as small as several miles of beach or as large as all of Prince William Sound. Herring sac roe and spawn-on-kelp fisheries are always prosecuted on individual regulatory stocks. Management of food and bait herring fisheries can be more complicated because they are conducted in the late summer, fall, and winter when herring from several regulatory stocks may be mixed together on feeding grounds distant from the spawning areas. Where possible, the BOF avoids establishing bait fisheries that harvest herring from more than one spawning population.

Interactions Between Herring Fisheries and Steller Sea Lions

Herring fisheries may affect sea lions or their critical habitat when vessel activity interferes with sea lion foraging, reduces prey availability, or alters long term herring biomass. Additionally, direct mortality may result when sea lions are caught in nets or other fishing gear (although no direct mortalities have been observed in the herring fisheries; Angliss and Outlaw 2005). Steller sea lions are attracted to areas where herring spawn to feed on the dense aggregations of herring present during the short spawning period. Observations of Steller sea lions in Prince William Sound indicate that sea lions may target herring despite the presence of much greater abundance of pollock (Thomas and Thorne 2001). These results suggest that under some conditions (e.g., when highly aggregated in shallow water), herring (or other high lipid fish) may be an important prey resource for sea lions (Sigler *et al.* 2004, Womble and Sigler 2006).

Because of the variability in the timing of herring spawn, fishery managers have learned to depend on the presence of Steller sea lions to determine when spawning is imminent. Managers generally begin flying aerial surveys over potential herring spawning grounds well in advance of the expected spawning event. For several weeks prior to spawning, herring are usually present adjacent to the spawning grounds, but they occur in depths too deep to be detected from aircraft. However, the presence of Steller sea lions and cetaceans on the spawning grounds alerts fishery managers to the presence of herring and impending spawning. Fishery managers usually note the presence of Steller sea lions in their field notebooks, occasionally recording actual counts. Steller sea lions are commonly observed in the middle of these fishing areas. There are two possible hypotheses regarding these observations:

1. Sea lions may venture into fishing grounds because the fishery is in someway either beneficial (or neutral), concentrating herring, creating confusion, and enhancing feeding opportunities for sea lions.

2. Some sea lions, perhaps the brave or curious ones or those that cannot afford not to forage (i.e., nutritionally limited), forage in these fishery grounds. Other sea lions may avoid these fishing areas due to the intense vessel activity, nets, and other hazards (e.g. shooting or other harassment). Sea lions that do choose to forage in these ares may have higher stress levels involved with avoiding vessels, gear, and dealing with noise, yet may appear to be foraging effectively but at an increased metabolic cost.

Presumably, fishing in areas that were previously unfished, yet utilized by sea lions, would change the manner and success rate of foraging sea lions. This could be either a positive or negative effect. Given the high caloric content of herring, the historical dependence on the species (Sinclair and Zeppelin 2002), and the large decline in herring biomass during the last century (Kruse *et al.* 2000), this fishery should be the subject of further study specifically to determine if there may be negative impacts on Steller sea lions. The important point is that although we have adequate data which displays that sea lions attempt to forage during the times and places when herring fisheries occur, we have little or no information on either the net impacts to those sea lions or other sea lions which may avoid observation because they elect not to forage. There is no way of knowing how many sea lions may be precluded from foraging in the spawning areas due to fishing activity. Steller sea lions are observed leaving the grounds within a few days after the herring have spawned. Fishery biologists make note of their departure since spawn deposition SCUBA biomass surveys do not begin, for safety reasons, until the sea lions leave the area.

There was no fishery at Hobart Bay in the spring of 2000 because the quota had been taken in the earlier food/bait herring fishery. However, if a fishery had occurred, managers would typically have allowed 6-12 hours of gillnet fishing about April 29. Steller sea lions were already in the area at the time of the first ADF&G aerial survey on April 19, diving on the deeply submerged herring schools, as were a number of humpback whales. Following the spawning event, large numbers of birds appeared on the beaches to feed on the herring eggs, noted in numbers of 11,000 to 20,000. Approximately 150 Steller sea lions were counted in the area. Similar descriptions of humpback whale and Steller sea lion presence on herring spawning grounds are available in field notes from other herring fishing areas.

Sea lions may depend on these short intervals of high prey availability to sustain them through other periods of low prey availability. Some individual sea lions may be able to adapt by learning to forage among the fishing boats, but others may choose to avoid the area and may thus forego prime foraging opportunities. Since we do not observe the sea lions that avoid fishing areas, we have no reliable way to estimate how many may be affected in this way, nor do we have a way to gauge the impact on those individual animals. For the sea lions that remain, we have no way to gauge their foraging success among fishing vessels relative to their potential foraging success in the absence of fishing vessels. Nevertheless, based on observations of interactions between the fishery and Steller sea lions, it is reasonable to conclude that some sea lions may be precluded by the fishery from foraging on spawning schools of herring. Likewise, the sea lions that do forage in the vicinity of the fishery may forage less efficiently due to active competition with the fishery for the available concentrations of herring.

Hundreds of individual sea lions may be affected by each of these brief fishery openings. The annual exploitation rate for herring is roughly 20% of the exploitable or mature biomass (Kruse *et al.* 2000), which is considered by the state to be conservative. This may be in relation to the target stock, but the question that arises is whether this is conservative from a sea lion perspective? This example from Hobart Bay is merely to make the point that foraging sea lions and herring fisheries operate in the same areas and times on the same resource.

State Salmon Fisheries

The state salmon fishery includes five species: chinook, sockeye, coho, pink, and chum. These fisheries are divided into southeast, Prince William Sound, Cook Inlet, Bristol Bay, Kodiak, Chignik, Alaska Peninsula, Kuskokwim, Yukon, Norton Sound, and Kotzebue management areas. The PWS, Kodiak, Chignik, and Alaska Peninsula areas report substantial harvest inside sea lion critical habitat in 2005 (Woodby and Hulbert). Salmon are taken by purse seines, gill nets, trolling, and beach seining via an extensive small boat fleet. The catch in 2000 was about 135 million fish, but Alaska's salmon landings reached an all-time high in 2005 of 221.9 million fish primarily due to high pink salmon catches, healthy salmon stocks and improving world-wide markets for wild fish. Economically, the salmon fishery is worth more than all other state fisheries combined.

Landings have increased for all salmon species except chum, and are trending towards a more temporally concentrated distribution earlier in the summer. Kodiak purse seine landings were twice as high in July and August of 2005 as compared to 1999, with more catch inside sea lion critical habitat. Chignik purse seine landings were concentrated earlier in June and July. Similarly, the South Alaska Peninsula (SAP) drift gillnet landings were more temporally concentrated in June as opposed to lasting into September as in 1999. SAP purse seine catches also peaked earlier in the summer.

The fisheries are managed for minimum escapement goals, where regional ADFG biologists have determined what level of escapement seems to produce the maximum yield per year. These methods have not been standardized, and range from aerial flights to determine if the streams are "full" to fish weirs and remote sonar counters. The timing of the fisheries corresponds with the various spawning time for each run, which is highly variable and which is managed on a stream by stream basis.

State managed salmon fisheries have direct impacts on Steller sea lions through the interaction of gear. In the gillnet fishery sea lions cause significant catch loss and gear damage by taking fish from nets and tearing large holes in the nets (Hoover 1988). Sea lions cause damage to purse seine nets when they swim inside the nets to eat salmon before the nets are closed (Hoover 1988). Prior to the mid-1990s the only quantitative study on interactions between sea lions and the Alaska salmon gillnet fishery was on the Copper and Bering River deltas and the Coghill district in south central Alaska (Kruse *et al.* 2000; Matkin and Fay 1980). During the three week spring salmon season sea lions damaged 1.7-4.9% of the weekly catch, and most of the damage occurred in outside waters where relatively few boats fished. Sea lions were infrequently seen in the Coghill district and were absent during the fall Copper River district season. Observers also monitored the Prince William Sound salmon drift gillnet (Copper River) fishery in 1990 and 1991. No mortalities were observed in 1990 and two were recorded in 1991. When these observer data are extrapolated, the mean kill rate for 1990 and 1991 is 14.5 sea lions per year (Kruse *et al.* 2000). The Alaska Peninsula and Aleutian Islands salmon drift gillnet fishery was also monitored during 1990 and no Steller sea lion mortalities were observed. There were no incidental serious injuries or mortalities observed in the Cook Inlet salmon gillnet fishery in either 1999 or 2000 (NMFS unpublished data); for Bristol Bay the annual sea lion mortality is thought to be 3.5 (Kruse *et al.* 2000, Ferrero *et al.* 2000).

Indirect adverse effects of state managed salmon fisheries on Steller sea lions stem from competition for seasonal aggregations of fish. Sinclair and Zeppelin (2002) found that Pacific salmon were the third most dominant fish in the diet of Steller sea lions, based on scats observed from 1990 to 1998 on summer and winter island sites across the range of the western stock of sea lions. Sinclair and Zeppelin (2002) observed that known seasonal and spatial distributions of aggregations of fish that are preyed upon by sea lions parallel the highest observed frequencies of occurrence in seasonal and regional prey consumed by sea lions.

The cumulative effect of early summer fisheries described above could affect sea lions during an important weaning period for juveniles and leading up to the birth of pups. Due to intensive salmon fishing activity in such areas during the same times when sea lions target concentrations of salmon, individual sea lions may feed less efficiently or may avoid these feeding opportunities entirely. The salmon escapement goals limit the commercial harvest to the surplus above the amount needed for spawning (Kruse *et al.* 2000), but these harvest controls probably do not eliminate competition for available salmon between sea lions and the fishery. However, as noted in Kruse *et al.* (2000) the abundance of salmon biomass increased dramatically during the time period that the western stock of sea lions has been in decline.

State managed salmon fisheries are open for relatively short periods, and only rarely remain open for 24 hours per day, 7 days per week (Kruse *et al.* 2000). Nevertheless, many of these fisheries take place at stream or river outlets where salmon congregate before moving upstream to spawn (Kruse *et al.* 2000). These same areas may provide important sea lion foraging opportunities on high density prey, enabling the sea lions to feed efficiently and survive other periods of low prey availability.

Summary of State Fisheries

State managed fisheries represent a substantial influence on the near-shore marine ecosystem in Alaska. Both parallel and state managed groundfish fisheries occur almost entirely within sea lion critical habitat (inside 3 nm). Because management of these fisheries is done on a regional basis, it is difficult to describe the overall impact of these fisheries on Steller sea lions or their critical habitat, although efforts such as Kruse *et al.* (2000) and Woodby and Hulbert (2006) are quite helpful. Most activity that occurs within state waters, including harvest and vessel traffic, occurs within sea lion critical habitat.

The parallel fisheries for pollock, Pacific cod, and Atka mackerel are by far the largest fisheries within state waters by weight. The pollock harvest is an order of magnitude larger than the state managed fishery. Parallel Pacific cod landings are greater than state managed landings everywhere except the Chignik area. Atka mackerel is currently not harvested in a state managed fishery.

Fisheries for Pacific cod, pollock, Atka mackerel, salmon, and herring occur throughout the year. According to Woodby and Hulbert (2006), Pacific cod is harvested in nearshore waters from January through May, pollock is harvested in January and early fall, and Atka mackerel is fished in the summer. Salmon harvest was at an all-time high in 2005, and was highest in June, July and August. The herring sac-roe fisheries occur in April and May, while food and bait fisheries occur periodically throughout the year.

Fisheries for species other than pollock, Pacific cod, and Atka mackerel could potentially affect Steller sea lions due to vessel noise, disturbance, pollution, and ecosystem level effects. Fisheries for other groundfish, including sablefish, lingcod, and rockfish, occur primarily in the summer inside critical habitat. Additionally, fisheries for several invertebrate species also occur inside state waters. Crab, shrimp, scallop, and sea cucumber fisheries all occur inside critical habitat. Tanner crab fisheries have reopened and occur in January, while Dungeness crab are harvested in late summer, and Aleutian Islands golden king crab are taken in the winter. Scallops were taken July through December of 2005, and small volumes of shrimp were taken in trawl fisheries from April through September. Kodiak Island in particular has a high level of fishing activity for groundfish and invertebrates year-round (Woodby and Hulbert 2006) which could result in changes to the sea lion prey field year-round.

4.5 Response of Steller Sea Lions and Critical Habitat

Differences in the timing and magnitude of the regional population trajectories in the 1970s, 1980s, and 1990s suggest that the overall western DPS decline was not caused by a single factor, but rather by the cumulative effect of multiple factors that had different relative spatial and temporal magnitudes. Indeed, the marked change in the rate of the decline since 1990 suggests that the factors that contributed to the more rapid prior declines may not be the most significant factors operating today (Bowen *et al.* 2001); in addition, there may have been density-dependent responses at lower population levels.

We have only a limited or qualitative understanding of how multiple factors interact to create an overall cumulative effect on sea lion populations. Data are insufficient to show what the natural dynamics of Steller sea lion populations have been. Such dynamics would be driven primarily by changes in the North Pacific ecosystem that affect carrying capacity (e.g., prey abundance), but would also be affected by changes in rates of predation and disease. Increased knowledge of both natural ecosystem dynamics and how human activities influence those dynamics is required before their respective impacts on sea lions can be delineated with certainty (NRC 1996, NMFS, 2001, NRC 2003). Yet, a number of theories attempting to explain the decline in sea lions and apparent changes in the structure of North Pacific ecosystems since the 1970s have been developed, and these involve direct (e.g., top-down) and indirect (e.g., bottom-up) or a combination of both types of forces (NRC 1996, Anderson and Piatt 1999, Merrick 1997, Orensanz *et al.* 1998, Estes *et al.* 1998, Francis *et al.* 1998, Trites *et al.* 1999, NMFS 1998a, NMFS 2000, Jackson *et al.* 2001, Hunt *et al.* 2002, NRC 2003, Springer *et al.* 2003). Depending on the emphasis placed within each individual theory, trophic cascades and systemic modifications were triggered alone or in various combinations by whaling, fishing, predation, or atmospheric and oceanographic changes.

The following is a synthesis of the direct and indirect impacts of various stressors to Steller sea lions and their habitat.

4.5.1 Response to Direct Impacts

As listed above, several factors act as direct or top-down sources of sea lion mortality; i.e., commercial harvest, intentional shooting, entanglements or incidental catch by fishing gear, disturbance, and predation. Direct sources of mortality were significant contributors to the sea lion population declines observed prior to the 1990s, when there were relatively large reductions in juvenile survival rates, and smaller reductions for adults (Pasqual and Adkison 1994, York 1994, Holmes and York 2003, Fay 2004). Since 1990, rates of mortality from harvests, shooting, entanglement, and incidental catch have been substantially reduced and likely has contributed to a rebound in both juvenile and adult survival rates (Holmes and York 2003, Fay 2004, Holmes *et al.* in review). Subsistence harvests of Steller sea lions continue but have declined substantially.

As previously described, predation by killer whales has the potential to be a significant additional top-down source of mortality (Williams *et al.* 2004, NRC 2003). Springer *et al.* (2003) proposed a hypothesis in which killer whales shifted their diet from large whales (following extensive commercial whaling in the 1950s and 1960s) to pinnipeds, resulting in sequential collapses of northern fur seals, harbor seals, and Steller sea lions, and culminating in the collapse of sea otter populations (see also Estes *et al.* 1998). This hypothesis, however, has been called into question because of inconsistencies with data on large whale catches, killer whale diets, and the spatial-temporal patterns of pinniped declines (Barrett-Lennard *et al.* 1995, Trites *et al.* 2006c, DeMaster *et al.* 2006, Wade *et al.* in press). Further review (see Section

4.2.3), suggest that killer whale predation is within the range of natural mortality of Steller sea lions and that current estimates of killer whale predation should not be a major influence on Steller sea lion growth rates. Analyses presented by Holmes and York (2003) is contradictory to top-down stressors, especially in the region of Kodiak Island where killer whales are known to specialize on sea lions, yet adult and juvenile survival are high. Although the NRC (2003) concluded that killer whale predation and top-down impacts were the likely driver for the decline of Steller sea lions, current information contradicts that hypothesis, and suggests that bottom-up factors may currently be more important. That is not to say that killer whale predation or shooting was not important in the past. Historical data does not allow us to better evaluate the potential impacts of these various factors (NRC 2003, NMFS 2006a), thus we must focus on current stressors. The Goodman PVA (in NMFS 2006a) may provide a tool to further evaluate the historical impact of these top-down stressors, but this approach will likely take years to develop and refine, and will only provide a sensitivity analysis.

4.5.2 Response to Indirect Impacts

4.5.2.1 Response of Steller Sea Lion Critical Habitat to Indirect Impacts

4.5.2.2 Response of Steller Sea Lions to Indirect Impacts

Evidence that indirect or bottom-up factors may have contributed to the decline observed from the mid-1970s through the late 1990s include reductions in size at age (Calkins and Goodwin 1988, Calkins *et al.* 1998), possible depressed late-term pregnancy rates (Pitcher *et al.* 1998), significantly reduced pregnancy rates for lactating females (Pitcher *et al.* 1998), and a decline in per capita natality of female sea lions at some rookeries (Holmes and York 2003, Fay 2004, Winship and Trites 2006, Holmes *et al.* in review). These responses by sea lions are opposite to those predicted by direct, top-down, factors (Bowen *et al.* 2001, NRC 2003), as body condition, growth rates, and natality should increase or remain the same when population abundance is reduced. These bottom-up factor(s) appeared to be affecting sea lions as early as the 1960s and 1970s (see Section 3.1.15.1), at about the same time that large numbers of sea lions were also killed directly (especially in the late 1970s and 1980s). The combination of reduced population abundance and poor body condition indices is consistent with a substantial reduction in carrying capacity (Gerrodette and DeMaster 1990, Calkins *et al.* 1998).

The changes in vital rates (see above) may have been a function of nutritional stress resulting from a combination of reduced prey availability and quality (Trites *et al.* 2006a). Two stressors were likely to have affected the prey field for Steller sea lions: (1) climate induced changes in the species composition, distribution or nutritional quality of sea lion prey (see review by Trites and Donnelly 2003 and Trites *et al.* 2006a), and (2) fishery-induced changes in localized or overall prey abundance and quality (Braham *et al.* 1980, NMFS 1998a, 2000). Both climate change and fisheries induced changes in prey communities likely have affected the condition of Steller sea lions over the last 40 years, but the relative importance of each is a matter of considerable debate.

The carrying capacity of the North Pacific for Steller sea lions likely fluctuates in response to changes in the environment (Hare *et al.* 1999, Overland *et al.* 1999, Stabeno *et al.* 2001, Benson and Trites 2002, Hunt *et al.* 2002, Shima *et al.* 2002, Trites and Donnelly 2003, Trites *et al.* 2006a), yet what may have been unusual about the decline in sea lions observed through 2000 is the introduction of large-scale commercial fisheries on sea lion prey. While large-scale groundfish fisheries began in the 1960s, their potential for competitive overlap with Steller sea lions (e.g., catches within what would be designated as critical habitat) increased markedly in the 1980s (NMFS 1998, 2000, 2001). Overall and localized fisheries removals of prey could have exacerbated natural changes in carrying capacity, possibly in non-linear and unpredictable ways (Goodman *et al.* 2002). Reductions in carrying capacity may have contributed to declines in natality that are believed to have occurred at some rookeries through at least 2002 (Holmes and York 2003, Fay 2004, Winship and Trites 2006, Holmes *et. al.* in review) despite climate shifts to potentially more favorable environmental conditions that may have occurred in 1989 and 1998 (Hare and Mantua 2000, Bond *et al.* 2003).

Although the “junk food” hypothesis (Rosen and Trites 2000a, Trites and Donnelly 2003) in its original form is not well-supported by available data (e.g., Rosen and Trites 2004, Calkins *et al.* 2005), changes in the overall energy density of the prey field due to both climate shifts and long term fisheries impacts, may have reduced the efficiency of sea lions and affected their ability obtain adequate energy to maintain body condition and full reproductive potential (see Section 4.6). In our review of climate and regime shifts, gadids were not necessarily affected across the range of Steller sea lions by the 1977 shift. Although it appears that EBS pollock did benefit from this change, GOA pollock and Atka mackerel likely were unaffected or affected in different ways that are still not clear. Also, the Steller sea lion population may have been increasing during the 1940s and 1950s during a time period that was rich in gadids, but may have been affected by nutritional stress as early as the 1960s and 1970s, before the 1977 regime shift. Results by Hennen (2006) correlate sea lion declines with fisheries around rookeries in the 1980s, and find no correlation between fisheries and sea lion dynamics in the 1990s after conservation measures were enacted around rookeries and shooting was prohibited[17] (Hennen 2006, Dillingham *et al.* 2006).

4.5.3 Synthesis and Summary of Responses of Listed Entities in the Baseline

Both direct and indirect stressors can affect Steller sea lion population growth and vital rates. In addition, both types of stressors can operate simultaneously and at various levels. Steller sea lions have been affected by climate and regime shifts, diseases, parasites, and predation for their entire existence, and humans have hunted them for food and for other uses for thousands of years (Walker *et al.* 1999, Dixon 1986). The impact of each of these factors has likely varied over time in response to marine ecosystem dynamics and predator abundance (e.g., killer whales and humans), as well as in response to the size of the sea lion population itself. Steller sea lions persisted in the North Pacific despite the adverse impact of these stressors, and they did so without an apparent loss of genetic diversity which would indicate that the population had gone through a “genetic bottleneck” (NMFS unpublished data). Therefore, for tens of thousands of years prior to the 1970s, Steller sea lions had adapted to and accommodated fluctuations in their carrying capacity due to natural variability, disease and parasitism, killer

[17] Numerous sea lion conservation measures were implemented throughout the 1990s, see Sections 4.4.1 and 4.5 for a thorough historical review.

whale predation, human-related kills, and apparently maintained, on average, a relatively large population size (i.e., above the point that would have resulted in an obvious genetic bottleneck). This is not to say that the population did not go through historical changes in population size or distribution as reported by Nelson (1887) or similar changes for seabirds (Causey *et al.* 2005), but that it appears unlikely that rapid and large population increases and decreases were common for sea lions. The western portion of the range of sea lions was probably at a relatively large population size at the beginning of the sharp declines in the 1980s, and may have been increasing prior to that decline.

In the last several decades, several stressors have developed as a result of human influence such as contaminants, incidental take, shooting, fisheries, and potentially global climate change[18] (NRC 2003, NMFS 2006). The absolute impact of each stressor on survival and reproduction during the sea lion population decline are unknown. Yet, based on several PVAs, there is a significant probability that either a portion of the range of the western DPS of Steller sea lion may be extirpated (Winship and Trites 2006) or that the entire western DPS will go extinct in the next 100 years (York *et al.* 1996, Gerber and VanBlaricom 2001, Goodman in NMFS 2006a). The eastern DPS is likely to continue to increase and appears to be large, healthy, and based on Goodman (PVA in NMFS 2006a) is not in danger of extinction or likely to become endangered.

It is likely that both direct and indirect stressors affected sea lions and their habitat at different times, and to varying degrees, to cause the sea lion population declines (NRC 2003; Table 4.8, Figure 4.34). Increases in both direct and indirect threats were necessary to account for the rapid rates of population decline in the 1980s that were accompanied by declines in juvenile survivorship, body size, and birth rate. Specifically, direct mortality from humans (e.g., legal and illegal shooting, incidental take, subsistence hunting) and killer whales were augmented by declines in carrying capacity associated with regime shifts, increased inter-specific competition, and fishing. A reduction in the rate of population decline in the 1990s suggests that the effect of one or more stressors also declined, possibly through density dependence or changes in human behavior. This coincides with the listing of Steller sea lions under the ESA and the imposition of a ban on shooting at or near Steller sea lions, fishing closures near rookeries, as well as a potential change in oceanographic conditions. Thus, there may have been a reduction in direct mortality from humans, a hypothesis supported by time series of juvenile and adult survivorship, as well as a shift to potentially more favorable environmental conditions. In addition, rates of predation may also have decreased through density dependence. The lower rate of population decline since about 1990 and the associated improvement in survivorship, but continued decline in the birth rate, suggests the sustained effect of indirect stressors and a reduction in the magnitude of direct threats.

[18] Global climate change is a highly debated theory, both on the mechanisms and results. See NMFS (2006a) for a short discussion of the topic. In this opinion we recognize the possibility of global climate change and the potential influence on sea lions and changing habitat and range. The southern contraction of the range of the eastern DPS may be in response to warming (see NMFS 2006a for this discussion).

NMFS PRD AKR is currently in a re-initiated consultation with NMFS SFD AKR over the potential impacts of the Fishery management Plans for Federal and State parallel groundfish Fisheries in the Bering Sea, Aleutian Islands and the Gulf of Alaska and the actions they authorize. The results of that analysis are not yet available, and thus, cannot be considered in this consultation. Thus, our conclusions, after that analysis, may change from those made above, based on full consideration of the results of that analysis. However, the results of the existing and past Biological Opinions on groundfish fishery impacts have been considered in this section as part of the environmental baseline.

5 Effects of the Federal Action

5.1 Introduction

Pursuant to Section 7(a)(2) of the ESA (16 U.S.C. §1536), federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of their critical habitat. This biological opinion assesses the effects of NMFS' proposal to fully implement the Preferred Alternative under the FPEIS for Research on Steller Sea Lions and Northern Fur Seals. This alternative, Alternative 4, was chosen by the agency to allow implementation of a research program with full implementation of conservation goals for both Steller sea lions and northern fur seals. As summarized in Section 2.1 of the Policy and Guidance Document (NMFS 2009:4), "NMFS selected the Preferred Alternative (Alternative 4: Research Program with Full Implementation of Conservation Goals) as the approach to issue grants and permits for scientific research on SSL and NFS. This alternative allows the agency to fully implement the recommendations in the species' conservation and recovery plans and does not limit the types of methods, locations, timing, sample sizes, etc. The Preferred Alternative includes all research activities needed to address all information objectives identified for both species of concern. This alternative includes the same types of research described in the status quo alternative, and also allows for activities that have not been authorized under the status quo, including new permits and permit amendments that were pending as of January 2006. It also allows for techniques and activities that have not been previously requested or authorized, including intentional lethal take." However, as is clear from the FPEIS, the Summary of New Information, and from the Policy and Guidance Document, these activities would still be required to meet the issuance criteria to ensure the proposed research is compliant with the ESA, the MMPA and implementing regulations. Additionally, while a variety of methodologies, including lethal take, can be proposed, NMFS must make specific findings prior to issuance of the permit. For the foreseeable future, NMFS has also chosen to implement this alternative with a more precautionary upper cap on research-related mortality than specified in the FPEIS (see details below). In the Policy and Guidance Document, NMFS specifies that research will be required to demonstrate a value to recovery of the species.

5.1 Background and Approach to the Assessment

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of federal actions to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR §402.02). Guidance on adverse modification analysis (Hogarth 2005) directs NMFS to rely upon the statutory provisions of the ESA to complete analysis of destruction or adverse modification of critical habitat. That guidance directs NMFS analysts to take the following approach to the assessment in the "Effects of the Action" analysis:

> "Characterize the direct and indirect effects of the action and those of interrelated and interdependent actions of the proposed or designated critical habitat. Describe how the primary constituent elements or habitat qualities essential to the conservation of the species are likely to be affected and, in turn, how that will influence the function and conservation role of the affected critical habitat unit(s) or specific areas. Conservation activities…outside of critical habitat should not be considered when evaluating effects to critical habitat. Based on the analyses under (1) and (2) above, discuss the significance of anticipated effects to critical habitat."

NMFS has previously consulted on a large subset of this action (NMFS 2007) and this consultation is a re-initiation of that consultation based on NMFS' proposal to fully implement, versus proceed with a limited implementation of, the Preferred Alternative in the FPEIS. In the 2007 Biological Opinion and in the 2007 FPEIS, NMFS provided considerable detail about the potential effects of the proposed action that are relevant to our evaluation. NMFS Permits Division provided us with an update of information as part of the reinitiation package. We have reviewed all of this information. Both the FPEIS and the 2007 Biological Opinion present analyses that are valid and helpful to an understanding of ways in which Steller sea lions and their critical habitat might be affected by the proposed actions. The FPEIS provided considerable analysis on full implementation. The Policy and Guidance Document developed by NMFS (NMFS 2009), with the help of the Independent Panel, "establishes the National Marine Fisheries Service's (NMFS) policy for implementation of the preferred alternative and the recommendations in Chapter 5 of the Steller Sea Lion and Northern Fur Seal Research Final Programmatic Environmental Impact Statement (PEIS) (NMFS 2007). This document also provides guidance for issuance of permits for research on Steller sea lions (*Eumetopias jubatus*) and northern fur seals (*Callorhinus ursinus*)."

NMFS (2009) clarified that "The purpose of establishing such policies and guidance is to promote consistent compliance with the PEIS and the National Environmental Policy Act (NEPA) for:

- reviewing permit applications and reports
- coordinating research
- monitoring effects of research
- monitoring effectiveness of research (in contributing to purpose and need in PEIS)

The Policy and Guidance Document is responsive to concerns raised in the 2007 Biological Opinion in which NMFS (2007a) expressed uncertainty regarding whether the NMFS Permits Division has sufficient structure and consistency in evaluation of permits to ensure that the issuance criteria under the ESA and the MMPA were adhered to. NMFS (2007a:7) wrote that:

> "After conducting a critical examination of the Steller sea lion and Northern fur seal research program, the decision-making process used to authorize research permits, and the general classes of activities the program would authorize, NMFS determined that the program would benefit from a stronger, clearly articulated decision framework that promotes a reasoned way to balance competing interests and competing risks to ensure that research activities authorized under the program would not permit an exemption to the protective restrictions imposed by the Marine Mammal Protection Act and the

> Endangered Species Act for a particular study or investigation *except* when a particular study or investigation would be expected to contribute to the conservation and recovery of the species."

Hence, we interpret this Policy and Guidance document not as modifying the scope of *potential* activities that will be considered for permitting, as described in the FPEIS under the Preferred Alternative but in providing detail as to how permitting of Steller sea lion and northern fur seal research would actually be implemented under that Preferred Alternative to ensure compliance with the ESA and the MMPA. It clarifies and reiterates the specific findings the MMPA and ESA require NMFS to make prior to the issuance of a research permit on an ESA-listed marine mammal relative to the purposes and the policies of those statutes. It clarifies processes for permitting and suspending permitted activities when a permit holder violates the ESA, MMPA, the permit, or the implementing regulations of either act. It specifies a clearly articulated decision framework that NMFS will use in the application review process to promote conservation and recovery of the species. This document also specifies limitations to total estimated research-related mortality that will be permitted. It specifies that requirements will be placed on permits related to monitoring the effects of research. Lastly, as detailed in the section on the Description of the Action, the Policy and Guidance Document does modify the implementation of the Preferred Alternative in another important way: it lowers the acceptable upper cap on research-related mortality to 10% of PBR for the foreseeable future. NMFS (2009a) wrote: "Until there is sufficient data or information to develop a more robust mortality risk assessment method, NMFS will limit research-related mortality to the levels permitted in 2007: below 10% of potential biological removal for each stock. These mortalities will be allocated among research applicants based on the types of research activities and numbers of takes requested."

In the FPEIS, NMFS (2007b) stated that the Potential Biological Removal (PBR) "…is a precautionary or conservative measure of human-caused mortality that could be expected to affect a population's ability to recover from a depleted state or to remain at a sustainable level. The PBR calculation contains provisions to account for uncertainty in population estimates and protects a larger fraction of annual productivity for depleted stocks through a recovery factor (Fr). For endangered populations such as the western DPS of SSLs, Fr is set at 0.1, so that 90 percent of the endangered population's annual net production is reserved for recovery of the population. NMFS has calculated that keeping human-caused mortality at or below PBR calculated with a recovery factor of 0.1 would increase the recovery time of endangered marine mammals by no more than 10 percent (Wade 1998). For the threatened eastern DPS of SSLs, Fr is set to 0.75 because the population has been growing consistently for over 20 years…" Because the calculation of PBR contains a recovery factor for these stocks, mortality levels that exceeded PBR would not necessarily cause a population to decline but could slow the rate of recovery." In the FPEIS, NMFS considered a mortality level above PBR as a "major" impact, although it would not necessarily cause the population to decline.

Because of the aforementioned, we refer to, adopt and/or reiterate much of the approach and portions of the analyses in the 2008 FPEIS, the Summary Document, and the 2007 Biological Opinion in this opinion as they represent a reasonable and valid approach to evaluation of the effects of the action on listed species and critical habitat. However, for each segment of the analysis, we evaluated whether new information is available that is relevant to our understanding of the ways in which particular aspects of this action could affect Steller sea lions and their critical habitat. We have evaluated how the existence of the Policy and Guidance Document modifies, if at all, our conclusions about the potential effects of a given effecter due to the clarification of how the permits program will actually be implemented. Further, for each type of research, we evaluate, at least qualitatively, both the potential positive and the negative effects of that research. By doing so, we can arrive at a comprehensive, both detailed and overarching, understanding of the impacts of full implementation of the Preferred Alternative which allows for a research program with full implementation of conservation goals.

In more general terms, we also supplement this previous analysis in several ways:

1) We discuss the action area as it pertains to our effects analysis.
2) We incorporate new information about: the status of the species and the critical habitat, the ways in which the expanded action differs from the action consulted on in 2007, and the ways in which the species could be affected by the action.
3) Compared to the 2007 Biological Opinion, we evaluate the full implementation of this action and thus, evaluate the potential impact from all potential research as it is described in the Preferred Alternative, including lethal take (which was not an activity proposed for permitting in the 2007 set of permits considered for the opinion).
4) We discuss the areas of uncertainty in our analyses and conclusions and the ways in which we have incorporated this uncertainty in our conclusions about specific effects.

NMFS has approached the analysis of the action through a series of steps. The first step identifies those aspects of the proposed action that are likely to have direct and indirect effects on the physical, chemical, and biotic environment. The area affected directly or indirectly by the action defines the action area for the consultation. The second step of our analyses identified the listed resources that are likely to be exposed to these effects in space and time. We took this step and clarified the action area in Section 2. For ease of reading, we reiterate it here:

The action area for this consultation encompasses the land and waters where the research on Northern fur seals and Steller sea lions would be authorized by NMFS. This includes coastal and estuarine waters and limited portions landward of the entire west coast of the United States, from southern California to Alaska, and portions of the United States' Exclusive Economic Zone. The extent of the action area considered herein is defined by the research activities proposed for authorization in the thirteen permits. While the majority of research activities would focus on animals located on rookeries, haulouts, and in waters surrounding these areas, the action area would include transit routes to the study sites (e.g., boat transiting from various ports along the western seaboard). The action area extends to transit routes because water travel may result in incidental indirect effects on non-target aquatic species, such as whales. The Alaska Sea Life Center, a captive animal facility, is also included in this action area. The action area also includes waters, haulouts, and rookeries adjacent within the Bering Sea, the Gulf of Alaska, and other areas of the North Pacific Ocean and adjacent areas where Steller sea lion or northern fur sea research may be authorized."

We have gone through these steps for each category of research activity that may be permitted under the preferred Alternative. The suite of activities considered are those given in the FPEIS under Alternative 4. This is our exposure analysis. If data are sufficient, in the exposure analysis, we identify characteristics such as the age, sex, and key life cycle interval, of the individuals of the species that are likely to be exposed to the effecter (e.g., breeding adult males, neonates, juvenile females, non-breeding adult males, etc.) and the populations to which they belong. After we identified which listed resources, populations of those species, and types of individuals within the population are likely to be exposed to a given type of effecter, we examine how the exposed individuals are likely to respond to the effecter. This could be either positive or negative. We first make this evaluation at the level of the individual and then, based on the effects on individuals, make inferences about the potential effect to the population.

The Action under Consultation is Intended to Aid in Conservation of the Affected Species

NMFS (2009b:1) summarized that the purpose for the proposed action:

"The purpose of conducting research on SSLs and NFSs, as stated in the SSL Recovery Plan (NMFS 2008) and NFS Conservation Plan (NMFS 2007), is to promote the recovery of the species' populations to levels appropriate to justify removal from ESA listings (in the case of SSLs) and to delineate reasonable actions to protect the depleted species (in the case of NFSs) under the MMPA. NMFS is the federal agency responsible for management, conservation, and protection of these species. NMFS facilitates research on SSLs and NFSs by awarding grants and issuing permits. This research may yield information that can be used by NMFS to develop more informed and effective management actions to promote recovery and conservation of SSLs and NFSs.

It is important to acknowledge that this action thus differs from typical actions (e.g., oil and gas leasing, harbor construction, naval exercises, etc.) on which NMFS consults because this action is being undertaken to help conserve the species. The action on which we are consulting here is an action that, in general terms (research) in envisioned in the ESA as an integral part of the definition of the terms "conserve", "conserving" and "conservation" of a species. It is recognized by the ESA and by NMFS (e.g., in the 1992 and the 2008 Steller Sea Lion Recovery Plans) that research is needed to help us formulate management actions to help these species recover. However, not all research would necessarily aid in the conservation of Steller sea lions. It is, therefore, incumbent upon NMFS to ensure that the purpose and need for the proposed action (as described above) is actually met and that the issuance criteria of the ESA and the MMPA are complied with to ensure that the research results in such a benefit to the conservation of Steller sea lions. Based on our review of issuance criteria and on the Policy and Guidance Document, we explicitly assume that this standard will be met.

Because of the nature of the action, the issue of beneficial effects to the species is more prominent than it is in many opinions in which the proposed action has nothing to do with conservation of the listed species and may only have the potential for adverse effects. However, as acknowledged by NMFS (2009a), it can be difficult to establish direct links between an activity (e.g., flipper tagging) or a specific project and the benefits realized by action NMFS might take based on information gained from the tagging to aid recovery. However, in the recently finalized Recovery Plan for Steller sea lions NMFS (2008a:xiv) identified substantive actions (including research actions). This list of identified actions can be used as a reference of whether the proposed research is likely to be of value to recovery of Steller sea lions.

Insight into benefits to the affected populations of Steller sea lions that are likely to be derived from the research can also be gained through consideration of what information would be lost if the research were not undertaken and consideration of whether NMFS could fulfill its obligations under the ESA to conserve the listed species.

In 2003 the Marine Mammal Commission (MMC) (MMC 2003) consulted with leading marine mammal researchers to determine future directions for marine mammal research. In the consultation, the MMC asked the participants to (among other things) identify and evaluate threats to marine mammals and to develop research recommendation to address these threats. The implicit assumption in this effort by the MMC was that research can be valuable in addressing the threats. In the volume that resulted from this consultation the MMC summarized that the expert group recommended the following strategies to improve marine mammal research:

- Develop long-term multidisciplinary programs suitably scaled to ecosystem complexity
- Ensure that population and ecosystem assessment programs are sufficient to inform management decisions regarding current and future threats
- Develop and validate specific, measurable and robust management standards to achieve the conservation goals or the MMPA and related legislation (including the ESA)
- Identify marine mammal conservation units essential to ecosystem health and function
- Increase international cooperation in studying and addressing human-related threats
- Properly assess and communicate the strengths and limitations of the scientific process, including measures of uncertainty that are an essential element of high quality science
- Address ultimate as well as proximate causes of environmental problems

The MMC (2003:xii) "…asked participants to predict the consequences of not pursuing a more integrated, holistic, and anticipatory marine mammal research agenda." Among the consequences identified by this group were the following:

- "The goals of the" MMPA, the ESA, "…and other environmental legislation will likely not be met, and marine ecosystems will continue to deteriorate."
- Some marine mammal populations will persist, perhaps in large numbers, but many of those that are presently endangered will decline to extinction…"
- Management and recovery efforts will remain reactive rather than proactive and will be confounded by uncertainty and controversy."

In the 2007 Biological Opinion, NMFS (2007a) wrote that:

> "Decisions made under the research program must be wary of two types of errors: (1) Authorizing and funding research on a protected species, when the research would result in harming the species' survival and recovery in the wild; and (2) failing to authorize or fund research that would be useful in promoting the conservation of the species. For example, if NMFS doesn't have a good idea of what the effect of a particular study activity is, we may falsely conclude that it would not reduce the

> species' likelihood of surviving and recovering in the wild when, in fact, it would…Conversely, if we don't understand how a species may respond to research activities, we may erroneously determine a study will adversely affect the species when, in fact, it will not…If NMFS incorrectly concludes that a particular research project would have no effect on the species when one actually exists, or if we conclude a particular research activity is more valuable than it actually is, we risk allowing research activities to go forward that should not be allowed because they cause undue harm to the species. If we incorrectly conclude an effect of a particular research activity or set of activities when none are likely and subsequently withhold funding or a permit to conduct the activity, we may risk losing important opportunities for research and new information that may lead to improved management of anthropogenic factors affecting the protected species."

With regards to Steller sea lion specifically, we note that the 1992 Recovery Plan for this species made specific recommendations for research to attempt to better understand threats that were causing the decline. Over the next decade, specific management actions were put into place to attempt to address known threats, and in so doing, to stop the decline and begin sea lions on the road to recovery. For example, regulations were put into place to halt intentional, non-subsistence-related shooting, to decrease competition between commercial fisheries and Steller sea lions for prey, to reduce disturbance at rookeries and haulouts, to reduce the incidental catch of Steller sea lions in commercial fishing operations, and to protect critical habitat from degradation. All of these actions followed some level of research that gained information about abundance and trends, body condition, threats, habitat use, foraging patterns, or other vital information. Thus, in the history of the Steller sea lion, there is demonstration of benefits to the species conservation through management that was informed by research. NMFS (2008s) has identified new information that is needed to aid in the recovery of Steller sea lions. The use of the Recovery Plan as a reference to determine whether the proposed study has value can help avoid one of those errors. External review and a period for public comment (as currently exists) can help avoid risks of research with unacceptable or avoidable levels of potential adverse effects to listed species.

Based on all of the aforementioned, we assume that research is a necessary part of conservation and that the listed species, the two distinct population segments of Steller sea lions, will be less likely to recover if research to guide recovery management actions is not undertaken. We assume that research that is designed to implement recovery actions identified in the 2008 Steller Sea Lion Recovery Plan is likely to have positive benefit to the recovery of the species, although we acknowledge that this is difficult to quantify. We note that the key issue in the permitting of research activities that could potentially have an adverse effect on individuals is taking steps to ensure that there is NET benefit to the species. As pointed out by the Independent Panel, this requires ensuring that research tasks provide high value information for recovery and that effects of needed research are minimized.

Assessment of Direct and Indirect Mortality Due to Research

After review, we have adopted the mortality assessment provided by NMFS (2007b) in the FPEIS. We note, as did the FPEIS and the 2008 Opinion, which many potential mechanisms exist for research injuries to occur, some of which may lead directly or indirectly to the death of individual animals. Some injuries may affect the ability of an animal to forage or behave normally but are not directly fatal (i.e., sub-lethal effects). The thresholds for sub-lethal effects (i.e., when they start to affect an animal's ability to survive) are not well known. There are many other natural and anthropogenic factors that also affect survival of individual animals and to attribute the fate of an animal to a particular factor can be difficult, especially for species that are difficult to track and observe over long periods of time. The key question for the impact assessment is whether or not effects on individuals translate into a population-level effect (i.e., reduced ability to recover, reduced population growth or fitness).

Types of Activities Associated with the Action and Potential Effects on Exposed Individuals

Very different kinds of activities could be permitted under the preferred alternative. We have excerpted information from the FPEIS that details potential research activities on Steller sea lions and Northern fur seals that requires a permit. This information provides the basis for our understanding of the kinds of activities that might be permitted. These include activities that do not require the researcher to be on site with the animals but do involve the possibility that the animals will detect the presence of the researcher; that require the researcher to go on site to a rookery or haulout; activities involving capture only; activities that require handling and sampling; activities that require captivity; and intentionally lethal activities.

In general terms, the potential effect of any given action on Steller sea lions will vary depending on many variables including its age (and for pups, its exact age, as its competency to avoid other animals and to swim changes quickly in the first months of life), sex, the physical circumstances under which the action occurs (e.g., the topography of the rookery and the distribution of animals on it), the animal's health and condition at the time of exposure to the action, the behavior of the researcher, environmental factors such as weather, etc. Researcher experience and qualifications will also influence outcome. However, as in the FPEIS, we assume that "…all researchers are experienced and qualified to fill their assigned roles and that all procedures are carried out under "best practices" conditions, including all mitigation measures specified in the relevant permits."

However, while there is this underlying variability in possible outcomes for a given research activity, different kinds of research tasks have inherently different risks associated with them, partially dependent on the proximity of the researcher to the animals and partially dependent on the invasiveness and novelty of the procedure. Effects on the population will be partially a function of the number of animals of different age and sex classes that are exposed to the research action, as well as the distribution of those animals throughout the range of the population. We do not have good information to understand how, or if, the effects produced by different procedures interact (e.g., if effects are additive, synergistic, etc.). However, the combined effect of all the research activities authorized at any one time on a population can be estimated somewhat crudely based on the combined intensity of expected responses, the scope of the permitted activities (e.g., number of individuals exposed), and the limits placed on real time known impacts (i.e., limits placed on known mortalities associated with field work for a given year).

In the FPEIS, the analysis of the direct and indirect effects of research activities is divided into three major components: an assessment of research-related injuries that lead to serious injury or mortality; an assessment of research-related effects on reproductive success; and an assessment of how well each alternative research strategy would address recovery and conservation objectives for the species. We have reviewed this information and taken a similar approach. Our evaluations of the potential positive effects of research are evaluated based on the project's likelihood of contributing information that is likely to be of value to recovery. In this assessment, we use the 2008 Recovery Plan for Steller Sea Lion as our reference. This document outlines NMFS's conclusions about those actions that are necessary to achieve the recovery of the listed species. If a research activity or method cannot be linked to an identified action in the Recovery Plan, we have evaluated the action in light of the threats to the recovery of Steller sea lions, as identified in the Recovery Plan and as identified based on any new information. NMFS (2007b) provides more detail related to the criteria for determining the impact level of each component in Table 4.4-1 of the FPEIS.

Activities in Which Sea Lions May detect Human Presence Only

Aerial surveys, boat surveys, and land-based observations are types of research activities in which Steller sea lions may detect presence of humans or at least detect a foreign presence (e.g., an airplane or a vessel) and be disturbed by that detection. No other adverse effect of these surveys or observations is expected. However, disturbance of sea lions can cause serious injury or even death in addition to more subtle impacts. While disturbance is the primary avenue through which sea lions can be affected by these surveys, such disturbance is possible in all other activities. Thus, we discuss this issue at some length.

In the FPEIS, NMFS (2007b) reviewed literature on disturbance effects in several species of wildlife. NMFS (2007b) also pointed out that animals may have both behavioral and physiological responses to disturbance. NMFS summarized: "A review of available literature on responses of numerous species to a variety of human activities suggests that the responses of individuals and their effects are highly variable and dependent on multiple factors. For example, Anderson *et al.* (1996) found that there were no long-term effects of military activities on moose, and Englehard *et al.* (2002) concluded there were no long-term effects on elephant seals from human disturbance. However, Kerley *et al.* (2002) found that roads and traffic did affect the reproductive success and survivorship on Amur tigers, and Blackmer *et al.* (2004) found that human disturbance affected hatching success and nest-site fidelity of Leach's storm petrel." NMFS also pointed out that disturbance may result in the release of stress hormones, with potential adverse effects on individual health. Wasser et al. (1997) studied stress hormone concentrations in fecal samples from northern spotted owls as a measure of response to disturbance. Similar studies have been undertaken on elk and wolves (Creel *et al.* 2002). Short-term physiological responses, such as elevated heart rates, have been measured in bighorn sheep and white-tailed deer (MacArthur *et al.* 1979; Moen *et al.* 1982).

Kucey and Trites (20050 reviewed of the effects of disturbance on pinnipeds have focused on two types of disturbance: anthropogenic and non-anthropogenic (e.g., environmental changes, storms, birds, other pinnipeds, or predators). To assess whether or not there is an effect of disturbance on pinniped haulout behavior, it is important to understand how a return to "normal" is defined. Allen *et al.* 1984 considered a normal condition to be attained when a certain percentage of the animals present at the time of the disturbance return to shore. Kucey

2005) evaluated day variation in numbers onshore and average densities. This author documented the number of SSLs hauled out before (one to two weeks), during, and after (one to two weeks) directed research disturbance and found that the assessment of recovery depended on the criteria used. Lewis (1987) reported that, in the case of SSLs, disruptions often affect entire haulout sites and rookeries. These studies are useful for assessing short-term effects of disturbance. However, they cannot evaluate whether there are more long term, persistent effects from disturbance. McMahon *et al. (*2005) studied the survival of endangered southern elephant seal pups (*Mirounga leonina*) that were handled repeatedly and subjected to intrusive research procedures in their first six weeks of life. They found no short-term (24 day nursing period) or long-term (first year of life and beyond) effects on survival. However, it is likely that the effect of disturbance or any stressor on individuals is going to be variable and to depend on age, sex, previous exposure to the stressor, nutritional and reproductive condition, and "any other stressor currently affecting the animal. The closer an animal is to the condition of allostatic overload when subjected to an additional stressor, the more likely it is that the additional stressor will have a deleterious impact. That is, the effect of a stressor often depends heavily on the context in which it occurs." (NRC 2005:50-51). Thus, we should not expect that a given stressor will have the same effect on all sea lions of all ages and reproductive conditions, throughout the range.

We expect that individuals will generally not react as severely to aircraft and vessel traffic as they would to researchers landing and presence on rookeries and haulouts.

In the FPEIS, NMFS (2007b) provided background related to "mechanisms of injury from presence of researchers on or near rookeries and haulouts. We have reviewed this background and relevant scientific information. Several points are important to understanding the impacts of the proposed action:

Researchers do not, and cannot, always detect an animal's response to disturbance and it is even more difficult to evaluate the responses of many individuals which are simultaneously exposed to a research activity Sometimes responses go unnoticed because of limitations in methods used to observe or measure responses. Other times responses are internal (e.g., physiological responses, and cannot be easily evaluated in the field or replicated in the lab. Even behavioral responses can be difficult to interpret or document. For those species or circumstances where responses may be detected, the type and intensity of response can vary greatly for reasons already discussed. As described below, researchers have observed a variety of behaviors and measured various physiological indicators of stress in Steller sea lion response to research activities.

Some animals exhibit no obvious behavioral response in response to some research activities (e.g., "researcher presence in view of animals" or "researcher presence among animals"). It is possible that these animals may have physiological responses associated with stress. Some sea lions move away from the researcher or toward the water without actually entering the water and others enter the water either in an "orderly" fashion or in a stampede. Other sea lions have been observed to "alert" and show a noticeable increase in awareness of the researchers (e.g., head up, vocalization, etc.).

NMFS (2007b) identified the following mechanisms for direct and indirect adverse effects (including injury and mortality if animals flee into the water or stampede) on Steller sea lions from these activities:

- Injury to pups from aspirating water.
- Injury to pups from being trampled by adults or other pups.
- Injury to adults and pups from landing on sharp rocks when jumping or falling off cliffs or rocks.
- Increased corticosteroid levels or other physiological stress responses, especially from prolonged or repeated exposure to disturbance.
- Increased energy expenditure with the potential for hyperthermia (excessively high body temperature which could lead to muscle rigidity, brain damage, or death) for those animals involved in strenuous or prolonged activity.
- Hypothermia (characterized by abnormally low body temperature and associated with rapid, progressive mental and physical collapse which could be life-threatening) for those animals forced into the water, particularly animals undernourished or in poor health.
- Death of pups by drowning.
- Increased risk of predation for those animals forced into water, especially pups and juveniles with limited mobility.
- Increased conspecific aggression (e.g., biting and pushing) among adults and from adults toward pups as animals try to reestablish or access territories on the rookery or reunite with their pups.
- Delay in return of nursing females to the rookery/haulout, leading to a malnourished or weakened pup, or slower pup growth.
- Failure of pups and mothers to reunite after separation resulting in pup death by starvation or exposure.
- Stress reactions that produce psychological and physiological responses, especially if disturbance is chronic or frequent.

Aerial Surveys

Aerial surveys are used to obtain crucial non-pup and pup counts. These data can be used to estimate population size, to evaluate population, subarea, and rookery trends, and to gain information about age structure and vital rates. In the 2008 Recovery Plan, the only priority 1 activity is to "estimate trends for pups and non-pups via aerial surveys. Priority 1 actions are defined as actions that "must be undertaken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future. Hence, it is clear that aerial surveys of this type are of very high value to the recovery of these populations.

However, there are also some risks due to potential disturbance. In the Alaska portion of the range, NMFS attempts to conduct pup surveys and non-pup surveys in alternate years (i.e., each kind of survey every two years). Additionally, there may be specialized surveys aimed at a particular region. This research activity has the potential to affect all Steller sea lions in Alaska on land or in nearshore waters at the time of a survey. The frequency of surveys outside of Alaska and at the Pribilof Islands typically less. For example, there has not been a state-wide range-wide aerial survey in California for many years (one is being flown this year). It is unlikely in any given year that all sea lions would be exposed to this activity since animals that are out to sea foraging (not on a rookery or haulout or in nearshore waters) would be unlikely to be exposed to a survey. The exposure to the survey is brief. Aerial survey teams now typically use high resolution photography to obtain data from which counts can be made. Standard protocols used in aerial surveys include flying over rookeries and haul out sites at slow air speeds (100-150 knots), approaching without banking, maintaining altitudes greater than 150 m, and limiting the time the craft is within the hearing range of the animals in the aggregation. Permit applications indicate the aircraft is in a given survey period for very short duration (less than 5 minutes according to applicant). They are not circling for long periods of time, as surveyors may have done in the past when counts were done visually at the time of the survey. Reports from aerial surveyors indicate that only a small percentage (less than 1 percent) of sea lions respond to the approaching survey planes. During aerial surveys of the eastern population conducted in 2004, researchers reported counting 17,000 Steller sea lions from the plane of which only 147 responded to the activity. Kucey (2005) reported evidence of agitation such as increased vocalizations, and agitated movements (Kucey 2005) from such disturbance. In previous decades, animals were sometimes observed to flee in response to low-flying aircraft, putting them at risk of serious injury or even death encountered in their escape attempts (Sweeney 1990). Sea lions have temporarily abandoned haulouts after repeated disturbance (Thorsteinson and Lensink 1962; Kucey 2005), and they have also continued using areas after repeated and severe harassment. Kenyon (1962) noted permanent abandonment of areas in the Pribilof Islands that were subjected to repeated disturbance (this is not repeated aerial survey).

More subtle (versus stampeding) responses to aerial surveys, or other activities that may disturb or startle an animal, may occur as a result of aerial surveys. However, because the exposure from this effecter is so brief, it is highly unlikely that any stress response is likely to cause adverse effects. Animals have evolved to deal with the kinds of highly transitory physiological disturbance responses that might occur due to such a short term stimulus. However, a greater risk from this activity is stampeding and crushing that might occur if animals fled into the water. Based on observer experience, we believe this response is not common. If this was observed, researchers would likely immediately break off the survey to reduce the magnitude of the disturbance. However, the Permits division should continue to require sufficient description of response to surveys to enable evaluation of the frequency with which such response occurs and to determine if such a response is more likely in some locations than others.

In summary, during aerial surveys, the area of exposure is large; thousands of individuals are potentially exposed to the sound and/or sight of the aircraft, and exposure time is quite brief. Available data indicate that the response of Steller sea lions to aerial surveys is highly variable, ranging from no detectable response (reported in the vast majority of cases given modern survey protocols) to the immediate and complete evacuation of haulout (Calkins and Pitcher 1982) with the potential for the stampedes, injury and crushing of animals. We note that early reports of response to aircraft may not be highly informative as to the kinds of response that might be expected now, given difference between past and present survey aircraft and protocols.

Vessel Surveys.

Vessel surveys are another important and common tool used in Steller sea lion research. Vessel surveys are used for counts of pups and non-pups as well as for brand resight, and for behavioral observations. Observations from vessels in which researchers may, or may not, subsequently go ashore are vital to identifying various kinds of threats. For example, recent information about the rate of entanglement of Steller sea lion in southeast Alaska is available because of observations made by researchers during brand/resight trips. The brand resighting observations also provide critical data used to estimate survival rates, natality, and population structure. These important pieces of information were identified in the Steller Sea Lion Recovery Plan as priority 2a tasks. Priority 2 tasks are tasks that must be taken to prevent a significant decline in the population/habitat quality or some other significant impact short of extinction. Hence, based on available information, we conclude there are multiple beneficial effects on recovery from these surveys.

The percentage of the population in the eastern DPS that is exposed to vessel surveys in a given year is relatively high. The percentage in the western DPS is considerably less since the logistics of boat surveys in highly remote areas of the Aleutians is more expensive and poses logistical challenges. The duration of exposure to any given survey is longer than for an aircraft survey but short relative to the breeding season, foraging opportunities, opportunities to nurse, or the lengths of time available for other key activities. As with aerial surveys, the primary mechanism of adverse effect is disturbance. Both behavioral and physiological responses may occur as discussed above. NMFS should provide guidance as to the maximum lengths of time observers should be at a given site, particularly if nursing pups are on the site.

Scat Collections

During scat collections researchers may go ashore to a rookery and/or haulout, during the non-breeding season, often when animals are not present to collect scat for diet and hormone studies. These data are quite valuable, especially for understanding key prey species utilized in different parts of the range. These data are valuable in evaluation of the potential threat to Steller sea lion recovery from commercial fisheries. Animals that are present on the haulout or rookery may be disturbed by the researchers. Potential effects would be similar to those expected for vessel survey, although the magnitude of the response may be stronger (see below).

Evidence for Relative Disturbance from Aircraft, Boats, and Scat Collections

Kucey (2005) recorded disturbance events from aircraft, birds, sea lions, humans, boats, and researchers collecting scat across 8 sites used by Steller sea lions in the summer and sites used in the winter/spring season. Kucey (2005) observed more than 1,000 disturbance events of which slightly more than 40 percent caused animals to leave the site. She found that scat collection disturbances caused all animals to enter the water when researchers went ashore, whereas she recorded about 5 percent of the animals leaving the haulout sites in response to aircraft disturbance (n=20). Boat disturbance, however, evoked greater responses than aerial disturbances with more than 15 percent of the animals leaving the haulout in response to watercraft (n=36). Kucey (2005) observed that the nature of the vessel approach (i.e., speed, noise, fumes, combined with other variables like weather) influenced the magnitude of the response. As noted above, given current aerial survey protocols, the expected level of response appears to be low. During aerial surveys of the eastern population conducted in 2004, researchers reported counting 17,000 Steller sea lions from the plane of which only 147 responded to the activity.

The variability in response highlights the need for researchers to implement "Best Practices" in their implementation of aerial and vessel surveys, and in on-site activities, to minimize disturbance. Based on our review of recent permit reports and applications, in most cases, this appears to be the case for this category of activities. Researchers who are leading these research efforts tend to be highly experienced and well qualified. However, in order to continue to refine and improve these best practices, the NMFS Permits Office will continue to evaluate the combined and cumulative effects of all non-lethal taking authorized by all issued research permits. As a matter of the permit application and issuance process the cumulative effects of such non-lethal taking (e.g., aerial or vessel based population survey caused harassment or localized disturbance resulting from intallation of remote monitoring equipment) will be determined, monitored and assessed on an ongoing basis throughout the year as well as by monitoring reports submitted by permitees, as required by permit conditions.

Mortality Assessment

Here we incorporate the assessment provided in the FPEIS. Table5.1 indicates that there would be an estimated 13 non-pups injured each year during aerial surveys, with approximately 1,280 non-pups entering the water each year. About 3,660 non-pups are predicted to enter the water each year during vessel surveys, with two non-pups injured during the disturbances. During land surveys, 150 non-pups are estimated to enter the water each year with two non-pups injured during the disturbances. As with the non-lethal take, the the NMFS Permits Office will continue to evaluate the combined and cumulative effects of all lethal taking in the course of conducting surveys as authorized by all issued research permits. The cumulative effects of aerial or vessel based population survey caused mortalities will be determined, monitored and assessed on an ongoing basis throughout the year through both application review process and as well as by monitoring reports submitted by permitees, as required by permit conditions.

Table 5.1
Reproduced from FPEIS (NMFS 2007b) Table 4.8-8
Estimated Mortality Due to Researcher Presence in View of Animals. SSL Western DPS The Preferred Alternative (4)

Activity	**Age class**	**Animals potentially exposed**	**Type of effect**	**Estimated proportion of animals affected**	**Predicted number of animals affected**	**Estimated mortality rate per affected animal[1]**	**Predicted mortalities (number of animals)**	**Mortality subtotal for activity**
Aerial survey[2]	pups	10,000	Observed mortality during activity			0	0.0	
			Alert	0.05	500	0.0	0.0	
			Enter water	0	0	0.001	0.0	
			Injured during disturbance	0.001	10	0.05	0.5	
	Adults and juveniles (non-pups)	128,250	Observed mortality during activity			0	0.0	
			Alert response	0.05	6413	0.0	0.0	
			Enter water	0.01	1283	0.0001	0.128	
			Injured during disturbance	0.0001	12.8	0.02	0.257	0.9
Vessel surveys[3]	pups	5,000	Observed mortality during activity			0	0.0	
			Alert response	1	250	0.0	0.0	
			Enter water	0	0	0.001	0	
			Injured during disturbance	0.01	50	0.05	2.5	
	non-pups (breeding season)	7,500	Observed mortality during activity			0	0	
			Alert response	1	375	0	0	
			Enter water	0.1	750	0.0001	0.075	
			Injury during disturbance	0.0001	0.75	0.02	0.015	
	non-pups (non breeding season)	9,700	Observed mortality during activity			0	0.0	
			Alert response	1	485	0.0	0.0	
			Enter water	0.3	2,910	0.0001	0.29	
			Injury during disturbance	0.0001	1.0	0.02	0.02	2.9
On land[2]	pups	5,000	Observed mortality during activity			0	0.0	
			Alert response	0.05	250	0.0	0.0	
			Enter water	0	0	0.001	0.0	
			Injured during disturbance	0.001	5	0.05	0.25	
	non-pups	15,000	Observed mortality during activity			0	0.0	
			Alert response	0.05	750	0.0	0.0	
			Enter water	0.01	150	0.0001	0.015	
			Injured during disturbance	0.0001	1.5	0.02	0.03	0.3
Subtotal for Table 1 - Estimated mortality due to researcher presence in view of animals								**4.1**

Notes: [1]Mortality rates associated with alert, enter water, and injured reactions account for unobserved or subsequent mortalities attributable to the activity.
[2]Estimate based on the number of animals expected to be present during survey.
[3]Estimate based on the number of animals expected to react to researcher presence.

Activities in Which Researchers Capture and Restrain Sea Lions

Many of the actions identified in the Steller Sea Lion Recovery Plan as high priority tasks (Pritory 2 (a) and (b)) that must be undertaken to facititate prevention of a significant decline in the population involve research requiring the capture and restraint of Steller sea lions. For both Steller sea lions and northern fur seals most of these captures and restraints are undertaken to enable the collection of specific types of samples to enable specific kinds of analyses (e.g., blood samples to evaluate health, detect disease, etc.) or to enable specific procedures (e.g., branding to enable evaluation of age-specific survival or reproduction rates, etc). However, as the actions of capture and restraint are associated with their own mechanisms for impact and apply to all activities that require such capture and restraint, we evaluate the mechanisms associated with these actions separately than those for the specific post-capture, post-restraint tasks.

NMFS (2007a,b) has noted that for land-based and at-sea activities (described in NMFS 2007b Appendix B) that require capture and restraint, there are risks of injury in addition to those involved in activities in which the sea lions detect human presence. NMFS (2007a,b) identified the following ways in which animals may potentially be injured during capture:

- Efforts to avoid or escape capture can lead to contusions, lacerations, hematomas, nerve injuries, concussions, and fractures, as well as hyperthermia and myopathy from increased muscle activity.
- Pups herded into large groups for processing or that pile up in response to disturbance on rookeries may be injured or suffocated under the weight of other pups.
- Pups attempting to reunite with their mothers after researchers leave may encounter lactating females who may aggressively displace and injure them.
- Capture myopathy is associated with prolonged or repeated stress reactions in many mammals (but it is uncertain if it occurs in pinnipeds) and characterized by degeneration and necrosis of striated and cardiac muscles. Capture myopathy may be fatal and may not develop until 7-14 days after capture and handling.

However, while these risks exist, available data do not indicate these negative outcomes are common given data from actual activities as they have been implemented in the recent past. We discuss this further in the section below on "Available Information on Realized Capture and Handling Risks".

Activities and the mechanisms whereby Steller sea lions or northern fur seals could potentially be injured as a result of sedation or anesthesia activities activities (described in greater detail in Appendix B of the FPEIS NMFS 2007b):

- Chemical immobilization for sedation or anesthesia requires an accurate assessment of an animal's weight and condition to determine the appropriate dosage. Miscalculation can lead to an overdose that may result in death.
- A dart-injected animal may be injured if it enters the water after being darted and later aspirates water or drowns as the drug begins to take effect.

- Dart injection of anesthetic into blubber rather than muscle tissue can lead to aseptic necrosis and large abscesses.
- Dart injections into the abdominal or chest regions can result in puncture of the stomach or lungs, which may be fatal.
- Darts may hit an animal smaller than intended, leading to an inadvertent overdose.
- Animals under sedation can develop hyperthermia (over-heating) or hypothermia (reduced body temperature) due to stress reactions and the effects of some drugs on thermoregulation. Both conditions can influence the physiological response of the animal to drugs or exacerbate existing health problems.
- Immobilizing drugs can result in respiratory depression or apnea (stopped breathing); muscle spasms; increased salivation, which can lead to choking; and complications for animals that already have kidney or liver diseases.

Proceedures in which animals may be injured during sampling, marking, and other research activities, including collection of various tissue samples, and attaching tags or scientific instruments (detailed descriptions of techniques are presented in Appendix B of NMFS 2007a, b). In addition to the following risks associated with these procedures, all of the handled animals are exposed to the risks of researcher disturbance and capture listed previously.

- Blood collection can cause pain, stress, damage to the vein, abscesses, and clotting, particularly when multiple attempts are made on the same animal.
- Biopsy punches for skin and blubber samples produce a small wound that has the potential for infection, especially when considering the unsanitary conditions of the environment. Muscle biopsy produces a small-diameter deep wound that can bleed excessively and tends to heal at the surface prior to deep tissue healing, thereby increasing the chances of abscess formation.
- Hazards of remote biopsysampling include inadvertently striking vulnerable areas such as the head or abdomen, darts that penetrate too deeply and cause excessive bleeding or tissue damage, stuck darts or broken tips remaining attached to the animals, causing irritation and possibly abscess and infection, and inadvertent repeated sampling of the same individual, thereby compounding the effects on that animal. Depending on the depth of penetration and force of impact biopsy darts can damage internal organs if they strike the abdominal area, resulting in a fatal wound that may not be detected by researchers at the time of sampling. Animals can also be severely injured if darts strike them in the head (Gemmell and Majluf 1997).
- Tooth extraction can result in infection and cause more than momentary pain, which could temporarily interfere with foraging behavior.
- External attachment of instruments to the fur or skin with epoxy can cause irritation and lead to increases in grooming behavior with reductions in foraging behavior and other normal behavior. The hydrodynamic drag created by the instrument can hinder swimming performance and result in increased energetic costs of swimming, potentially affecting foraging efficiency.
- The potential long-term effects of injecting SSLs with substances for research purposes, such as isotope-labeled water and Evan's blue dye, and collecting serial blood samples have not been well studied. Also, these procedures necessitate the extended restraint of animals, which may increase the risk of stress-related effects and behavioral changes when the animals are released.

All procedures that require insertion of needles carry the risk of infection and abscesses that may affect an animal's general health.

- Stomach intubation carries the risk of introducing fluids into the trachea and lungs, which may lead to pneumonia.
- Enemas and fecal loops carry the risk of perforating the rectum, which may lead to peritonitis.
- Surgical implantation of instruments is performed under anesthesia, which eliminates pain during surgery, but there may be complications from the anesthesia, as well as considerable pain during healing, which may take weeks or months and could inhibit normal foraging behavior, reproductive behavior (including lactation and mating), and the ability to escape predators. There is also a substantial risk of infection associated with exposing deep tissues or penetrating the abdominal cavity.

Mechanisms and procedures whereby Steller sea lions or northern fur seals could be injured as a result of the placement of individual identification marks such as plastic tags and applying hot-brands (as detailed in Appendix B of NMFS 2007b)

Information obtained from individually marked animals is an essential component of numerous tasks identified as high priority events that could contribute to the recovery of Steller sea lions (NMFS 2008) and to assist meeting the objectives of the Conservation Plan for the Northern Fur Seal (NMFS 2007). A detailed review of these procedures, rationale for a utilizing hot branding as a preferred approach in many situations, and the various short and longer term effects of each of these procedures is attached as Appendix E. In brief, the following risks might reasonably be anticipated:

- Use of dyes, bleach, paint, or other chemicals to temporarily mark the pelage of SSLs or NFSs can potentially cause irritation, and some of the chemicals can be toxic if ingested, and, if they get into an animal's eye can result in blindness. Additional physiological or behavioral effects of temporary pelage marking are unknown, but potentially could alter thermoregulation or grooming behavior.
- Flipper tags create puncture wounds that produce more than momentary pain, include chances of infection, and may also pull out over time, creating a rip in the flipper.
- Hot-brands are the permanent marking method currently used for SSLs and can lead to stress, more than momentary pain, wounds that remain open for prolonged periods, and infection.

Of all marking methods available, only hot-branding produces a permanent mark that can be easily and reliably read from a distance. This allows for higher resight rates with less disturbance than obtainable with other marking methods. Though freeze-branding has been used in some pinniped studies, difficulties with logistics, brand application and legibility exist and thus hot-branding remains a preferable method for Steller sea lion studies. Mortality related to branding at rookeries is low, and a result of pup behavior and anesthesia complications rather than branding. For example, between 2000-2005 some 4,231 Steller sea lions were branded, with 18 associated mortalities being reported – all resulting from suffocation or drowning from pups piling when corralled, none resulted from branding (Appendix XXX). There seem to be no longer term consequences of hot-branding on growth rates or survival, and brand-associated wounds generally heal within the first year of life. Current studies of hot-branded Steller sea lions in the U.S. will eventually contribute to survival rate estimates with high precision and minimal impact on individuals or populations.

Mechanisms to limit, account for and monitor the authorized taking of research- related mortality.

We note that while all of these risks associated with the preceeding activities which NMFS (2007b) identified exist (as negative outcomes are possible for nearly any medical procedures, for example) for the relevant subgroups of activities (capture and restraint, sedation or anesthesia, and sampling, marking, and other research procedures) it is important to consider whether these risks are likely, and even if they were, what precautionary measures NMFS has built into the permitting process to ensure there are not population-level effects due to the accumulation of such outcomes. There are several types of information that are relevant.

First, NMFS has built into the action an across the board upper limit of cumulative research-related mortality that is acceptable on an annual basis taking all issued permits as a group into account (e.g., less than 10% of PBR for the western DPS) (NMFS 2009a). Additionally, NMFS conditions permits to require timely notification and review in the event of a serious injury or mortality. This requirement protects Steller sea lions from a potential situation in which a researcher, or researchers, repeatedly undertakes actions during a given field effort that results in serious injury and/or mortality.

In general, because of the experience and qualifications of the researchers, we expect such negative outcomes to be rare. However, if an animal dies or is seriously injured as a result of research (e.g., due to drug overdose, as identified as a potential negative outcome above), permittees are required to report the death to NMFS. These real time limits, as well as the upper limit on total research related mortality from all permits are deliberately precautionary to avoid the potential for large numbers of deaths due to research activities. In order to illustrate this, we examine a typical currently operative permit that was issued to an ADF&G investigator in June, 2007. This permit contained the following language in the "Terms and Conditions" section:

> "1. Personnel listed in Condition C. 1 of this permit (hereinafter "Researchers") may conduct activities authorized by this permit through August 1, 2009. This permit expires on the date indicated, can not be extended, and is non-renewable."

By this term and condition (which is non-discretionary), NMFS is specifying who can undertake the research and over what period.

Other conditions of this permit include:

> "2. Researchers must suspend all activities under this permit in the event serious injury or mortality of protected species reaches 3 Eastern Steller sea lions (any age, either sex) or 1 Western Steller sea lion (any age, either sex) during a single field trip or over the course of a permit year. The Permit Holder must contact the Chief, NMFS Permits, Conservation and Education Division (hereinafter "Permits Division") by phone…within two business days. The Permit Holder must also submit a written

incident report as described in Condition E.2. The Permits Division may grant authorization to resume permitted activities based on review of the incident report and in consideration of the Terms and Conditions of this permit.

3. If authorized take is exceeded, Researchers must cease all permitted activities and notify the Chief, NMFS Permits, Conservation and Education Division (hereinafter "Permits Division") by phone…as soon as possible, but no later than within two business days. The Permit Holder must also submit a written incident report as described in Condition E.2. The Permits Division may grant authorization to resume permitted activities based on review of the incident report and in consideration of the Terms and Conditions of this permit.

4. Activities under all permits for takes of endangered Steller sea lions will be suspended, pending review, if the total number of research-related mortalities of endangered Steller sea lions reaches 10 animals under any combination of permits. In the event that research is suspended because combined mortalities of endangered Steller sea lions reaches 10, research may recommence upon review of the information submitted by permit holders on the cause(s) of the deaths and authorization by the Chief, Permits, Conservation and Education Division. In the event that the total number of research-related mortalities of endangered Steller sea lions reaches 20 animals under any combination of permits, activities under this and any other permit for takes of endangered Steller sea lions will cease pending review of the circumstances and amendment of the permits as appropriate."

Hence, there are requirements built into permits that prevent multiple serious injuries (defined by regulation as any injury that will likely result in mortality) or deaths from occurring either due to multiple problems from a single procedure or a combination of procedures without triggering the requirement for the activity to stop and for timely review by the Permits Division of the circumstances associated with the serous injury or death. If, for example, NMFS received notice of multiple deaths resulting from the use of a certain drug, or resulting from a certain new procedure, and the evidence before NMFS indicated that the researchers either were not taking adequate precaution to minimize such risk or that such outcome was likely, NMFS has the discretion ("NMFS **may** grant authorization to resume) (bold font not in original) to allow the activity to proceed, or not.

Additionally, we note that the level of risk of these negative outcomes occurring is likely to be strongly associated with the qualifications of the researchers and/or veterinarians undertaking the activity, just as complications from any medical procedure vary depending on the qualification of the personnel involved. As noted above, NMFS reviews the qualifications of researchers in permit review, including past success (or failure) with a given procedure. NMFS (2009a) has included an element of investigator expertise in their evaluation of permit applications. In Appendix D of the Policy and Guidance Document, NMFS (2009) provides an analytical framework that Permits Division analysts will use in their evaluation of permits. In Section 2.3 of this document, NMFS lists questions that will be used to guide evaluation of whether permit applications meet ESA issuance criteria. Question E.6 of the framework is the following (bold font not in original):

> "Has the applicant demonstrated that the personnel to be involved in the taking have appropriate prior experience with the same or similar species and have demonstrated success with the proposed or analogous methods?
>
> Consider that the experience of personnel who will be engaged in activities with higher potential for serious injury or mortality should be commensurately greater than that of personnel who will be engaged in "lower risk" activities…"

We note that NMFS (2008b) wrote: "All research activities authorized under Alternative 4 would meet the statutory and regulatory requirements of the permit process, including criteria for experienced research personnel, the use of "humane" procedures to minimize pain and suffering, and implementation of permit conditions to mitigate potentially adverse effects. The resulting research program is therefore assumed to be conducted under conditions that minimize disturbance and the chance of harm to the animals."

NMFS (2007b) provided us with an estimated total direct and indirect mortality from Capture and Restraint activities of 12.4 SSLs per year, out of the total capture effort of 1,560 pups and 1,285 non-pups per year. They explained that this total includes five intentional lethal takes. It is our understanding that the current set of permits does not request intentional lethal takes. It is not clear that such takes could be authorized in the foreseeable future. In the Policy and Guidance Document, NMFS (2009a) gave their framework for evaluating requests for intentional lethal take:

> "M.19. If lethal taking, either intentional or unintentional, is requested, or is otherwise possible due to the nature of the activity, how has the applicant justified that non-lethal methods are not feasible?
>
> Note that feasibility is not based on "ability," as in cost or ease of doing something, but to possibility, as in an alternative exists, regardless of cost or ease of carrying it out.
>
> M.20. If lethal taking from a depleted stock is requested or otherwise possible due to nature of activity, how has the applicant justified that the results of their research will directly benefit that stock or species, or otherwise fulfill a specific critically important research need identified by NMFS?
>
> Note that an adequate justification for "directly benefit" should directly link the information to be gained from the study to a specific management or conservation action that would likely result in an improvement in the status of the stock or species.
>
> M.21. Has the applicant appropriately identified and adequately explained the processes for research-related mortality and associated probabilities of such mortality?
>
> Note that there can be more than one process that can lead to mortality, such as immediate effects of a drug interaction versus longer term effects of an infection or internal bleeding, or an injury that hinders feeding.

In evaluating this application, also consider past records for the same or similar activities, by the same applicant and others.

NMFS (2009a) clarified that: "As with other activities, capture efforts, and therefore the number of takes per year, are expected to vary between years under Alternative 4. The numbers used in the mortality tables represent a "maximum effort" year, and therefore the maximum estimated mortality risk per year, which may only pertain to a few years within the five-year permit period. The majority of estimated mortalities (5.3 animals per year) could result from capture and use of an inhalable anesthesia (e.g., isoflurane), with most of those estimated mortalities involving non-pups (4.4 animals per year) rather than pups (0.9 animals per year). The next highest estimated mortality (1.3 animals per year) could be from non-pups captured with injectable agents (darts). Most of the remaining estimated mortality (0.7 animals per year) could result from capture and physical restraint of pups."

In describing the action, NMFS (2007b) clarified that, under the Preferred Alternative, they assumed that there would be an increased effort to capture and recapture breeding-age females in order to attach satellite transmitters and for other sampling/testing purposes. Current permits prohibit the use of the available injectable anesthetic (i.e., Telazol) on females potentially lactating or pregnant (essentially all mature females) due to concerns about potentially adverse effects of Telazol on fetal development and nursing pups. Because darting with Telazol is the most efficient means of capturing and recapturing specific large animals, this restriction limits the ability of researchers to work with breeding-age females. NMFS clarified that to expand research efforts with breeding-age females under the Preferred Alternative, either studies would need to be conducted that demonstrated the safety of Telazol, or new techniques/drugs would need to be developed to enable the capture of these breeding age females. NMFS (2007b) also clarified that they assumed "…that new, experimental drugs and procedures would be safety-tested and refined on surrogate species first (e.g., California sea lions or other non-ESA listed species) but that the new techniques would eventually be authorized for use on the western DPS SSLs…Permit conditions would contain mitigation measures to minimize the risk to individual animals, but the initial transition to use on SSLs could still be considered experimental and potentially lethal to a targeted female and her dependent pup. One way to conservatively estimate the risk of a potentially dangerous procedure in the mortality assessment tables is to assume that a new procedure will be lethal until the actual risk values are established by experience." NMFS (2007b) further clarified that they included small number of "intentional lethal takes" in their Table 4.8-10 to illustrate the policy that intentional mortalities could be authorized under Alternative 4. They stated that the number of intentional mortalities under Alternative 4 was set to five in the EIS "…only as an example of how requests for intentional mortality (e.g., euthanasia of moribund animals) and/or potentially lethal experimental procedures (as described above)" could be addressed in the risk assessment tables as part of an overall risk assessment for a given scope of research. It is important to note that, as is the case for all the other take numbers assessed under Alternative 4 for particular research activities, NMFS would be under no obligation to authorize five lethal takes or limit the number of lethal takes to five in the future. The numbers used in this assessment are proxies for the numbers and types of takes that researchers may request in permit applications in the future."

NMFS (2007b) estimated the total direct and indirect mortality from Handling and Sampling Procedures on animals in the wild as 3.3 SSLs per year. The estimates for mortality associated with Handling and Sampling should be interpreted as estimates of additional mortality from the handling and sampling procedures themselves. Under the Preferred Alternative, NMFS (2007b) assumed that there will be an increase in the number of pups and non-pups captured and an increase in the number of procedures done on captured individuals to address conservation objectives. NMFS (2007b) noted that the total number of takes permitted for Handling and Sampling Procedures (expressed in units of "procedure-animals" in the table) would be greater than the number of animals captured since many captured animals undergo multiple procedures. Under this Alternative, NMFS (2007b) has assumed that "…700 of the 1,560 pups captured per year would be hot-branded. In addition, those 1,560 captured pups would be subject to an average of 3.0 relatively low-risk procedures and 0.5 relatively medium-risk procedures. Out of the 1,285 non-pups that would be captured per year by various means, 300 would be hot-branded. In addition, those 1,285 non-pups would be subject to an average of 6.0 relatively low-risk procedures and 1.8 relatively medium-risk procedures each. The largest contribution to the estimated mortality in this table is from relatively low-risk procedures (0.8 non-pups and 0.5 pups per year). Hot-branding contributes an estimated 1.4 mortalities per year, essentially all pups. Relatively medium-risk procedures account for about 0.6 mortalities per year (0.5 non-pups and 0.2 pups per year). Under Alternative 4, it is assumed that 30 non-pups would be subject to relatively high-risk procedures, but this is expected to account for less than one mortality per year.

Under the Preferred Alternative, NMFS (2007b) assumed that the number of animals taken into temporary captivity for experimentation would increase to 26 non-pups per year. They assumed that the estimated total direct and indirect mortality from Capture, Temporary Captivity, and Release is 0.2 SSLs per year (see Table 4.8-12 in the FPEIS). NMFS (2007b) stated that this estimated risk of mortality likely represents a "worst-case scenario."

<u>Conclusion for Mortality Effects</u>

NMFS (2007b) estimated direct and indirect mortality from research under Alternative 4 is 29.SSLsper year from the western DPS, which is 12.7 percent of PBR for this population (234 animals). However, as clarified in the Policy and Guidance Document, NMFS has decided to continue the current more precautionary policy of limiting total estimated research related mortality to less that 10% Of PBR. The research would be conducted across the geographic range of the population. However, NMFS (2007b) also concluded that it would "…therefore not be known at the time of permit issuance how permittees would distribute their activities within a large area. These could range from being widely dispersed across the range of the species to being concentrated in a few locations. Disturbance effects that lead to mortality are likely to occur given the current research techniques used. Although each exposure may be brief, individual animals could be affected by different research activities more than five or six times per year…" Finally, the cumulative annual research related mortality is monitored and tracked both in a year around real time process through mandatory reporting to the Permits Office, as well as through a NMFS sponsored workshop held each January at the conclusion of the Arctic Science Conference in Anchorage.

Sub-Lethal Impacts

In the Summary of New Information, NMFS (2009b) concluded that "The potential for sub-lethal effects of research…remains unknown, as concluded in the PEIS." In the FPEIS, NMFS identified the following potential mechanisms for sub-lethal effects on Steller sea lions:

- Physiological responses to stress that cause failure of embryonic implantation or re-absorption of fetuses.
- Injury to the reproductive organs or damage to hormonal regulation that leads to temporary or permanent sterility.
- Changes in maternal behavior that reduces feeding of pups, affecting growth rates.
- Delayed sexual maturation due to slow growth or poor health.
- Loss or shrinkage of territory, and therefore access to mates.

However, the Summary Document reaffirmed what the PEIS had already stated: direct evidence for the occurrence of most of these mechanisms in SSLs is weak or lacking altogether because research on the sub-lethal effects of different research techniques have not been conducted for most activities in the proposed action.

Finally, the degree of sub-lethal effects will be assessed by the Permits Office on a cumulative annual basis for the sum total of all authorized research related activities (all issued permits). This assessment is ongoing, both as applications requesting take are reviewed and permits may be issued; but also as reports, required by permit condition, are received and monitored by the Permits Office.

Available Information on Realized Capture and Handling Risks

There are unpublished but summarized data regarding capture and handling risk to Steller sea lions. Fadely et al. (2008) directly estimated capture and handling mortality risk associated with captures of juvenile Steller sea lions in Alaska during studies of foraging behavior and physiology. By examining data on satellite-tagged animals, they estimated indirect post-release mortality. In this study, Fadely et al. (2008) reviewed capture date on juveniles (2-35 month old) that were captured either on land using hoop nets or underwater. These young sea lion juveniles were physically or chemically restrained to obtain samples related to studies of their health, physiology and foraging behavior. These animals were sampled in a variety of ways including: blood draws, tissue biopsy, stomach intubation, permanent marking, marker injection, and transmitter attachment. Most at these animals were anesthetized using inhalable isoflurane. Some of the animals receiving only attachment of satellite tags were physically restrained. Three of 464 juvenile sea lions that were captured and handled died, for a known mortality rate of 0.6%. One of these animals died during hoop net capture resulting in a capture mortality rate of 0.002±0.003 mortalities per capture. No mortalities occurred during physical restraint. Two animals died due to complications with anesthesia equipment (a rate of 0.004±0.003 mortalities per anesthetic restraint). Fadely et al. (2008) noted that an observed capture and handling mortality rate of 0.6% is low when compared to that observed in recent studies of other medium to large sized carnivores. Fadely et al. (2008) also estimated mortality of radio-instrumented animals. They found that:

Post-release mortality was less than 1.6% based on telemetry and resight of branded animals.
Combined maximum capture and handling mortality rate was less than 2.2%, which also includes natural mortality.
Instrument transmission duration, as a proxy for post-release mortality rate, was unaffected by time held, time under anesthesia, and sea lion condition.
Satellite tag function and geographic variability in resighting effort affected their estimates of mortality.

In another recent study, presented at the 2008 Alaska Marine Science Symposium, Fritz et al (2008) remotely monitored attendance and behavior of Steller sea lions at Marmot Island, a rookery in Alaska, one to three times daily in June and July every year from 2000 to 2005. In 3/6 years, scientists landed at the rookery to capture, sample, measure, and permanently mark sea lion pups. Fritz et al. (2008) found that all or most adult and juvenile sea lions entered the water in response to the disturbance caused by researcher presence on the rookery (range of 8-10 h on shore, 1 day/year). Pups remained on shore. Researchers herded the pups into small groups for study. Fritz et al. (2008a) found that research disturbance reduced the proportion of female sea lions resting ($p=0.023$), increased the proportion of males that were active ($p=0.042$), and increased the proportions of females exhibiting aggression ($p=0.004$) for 1-5 days postdisturbance, after which proportions returned to pre-disturbance levels. These were the only adult female and male behaviors affected by research disturbance. No detectable changes occurred in juvenile sea lion behaviors. The authors summarized that "comparison of model analyses of counts of adult females and juveniles, territorial males, pups and all non-pups using QAIC revealed that inclusion of research disturbance effects did not improve fits to the data if variability between and within years was also permitted. These results indicate that the effect of research disturbance on the seasonal pattern of attendance was indistinguishable from natural variation."

We also noted that in the western DPS, survival rates, based on branded animals, is relatively high. The estimated cumulative survival rate of female western Steller sea lions through age 4 in the period 2000-2005 was double that of the late 1980s and is similar to that estimated for the pre-decline (1970s) population (Fritz et al. 2008b).

Effects on Critical Habitat

In the 2007 Biological Opinion, NMFS concluded that:

"Critical habitat for this species has been designated for listed Steller sea lions, however, the proposed action is not expected to affect that area and no destruction or adverse modification of that critical habitat is anticipated."

To a large extent that remains true. Most of the activities have an effect on the Steller sea lions themselves, not on the critical habitat. However, we note the following:

The proposed action does not appreciably affect prey availability within aquatic areas of critical habitat, it does not affect air quality, and it does not affect substrate or exposure to wind and wave.

Additionally, at least one current permit application proposes to put in place a fixed scale or scales that would allow for the remote weighing of Steller sea lions. Such a scale is being tried to try to get better information of Steller sea lion body condition with minimal impact to the Steller sea lions. However, the researchers will be putting a semi-permanent anthropogenic device in place on the terrestrial critical habitat. We are not aware of information that indicates this device will modify the ability of the critical habitat to serve its necessary conservation value for the species.

Lastly, these activities could have adverse effects on critical habitat if researchers were to contaminate the terrestrial habitat or nearby waters. This could occur if human garbage or human waste was deposited on the terrestrial habitat or in the water. NMFS should ensure that all human waste and garbage are removed from the site. This requirement is within NMFS's discretion and thus, we assume, for the purposes of the analysis, would be imposed as part of terms and conditions on permits to minimize the potential for adverse effects.

6 CUMULATIVE EFFECTS

6.1 Overview

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Past and present impacts of non-federal actions are part of the environmental baseline discussed in section 4 of this Biological Opinion. The cumulative effects of future state, tribal, local, and private actions on Steller sea lions, including both lethal and nonlethal effects, are considered below and the various sources of potential future Steller sea lion mortality, including anthropogenic sources and predation.

The 2008 Recovery Plan for Steller Sea Lions provides the most comprehensive recent review of various threats to the recovery of the eastern and western DPSs of Steller sea lion. Other summaries or syntheses of factors that may affect recovery of these populations include the FPEIS (NMFS 2007b) and the Summary Document (NMFS 2009b), the 2008 Alaska Marine Mammal Stock Assessments (Angliss and Allen 2008), Atkinson et al. (2008), MMS' FEIS on Cook Inlet Oil and Gas Lease Sales 191 and 199 (MMS 2003) and chapters in Trites et al. (2006). Loughlin and York (2001) provided a detailed accounting of the various sources of Steller sea lion mortality, including anthropogenic sources and predation.

In the Baseline Section of this Opinion, we provided updated information about factors known or suspected to affect Steller sea lions in the past and up to the present.

The Recovery Plan clarified that some factors which are thought to have contributed to the decline of Steller sea lions have now been mitigated so that the level of effects is substantially reduced (e.g., intentional, non-subsistence-related, shooting) or in some cases (e.g., commercial harvests) eliminated. Given available information, we assume that for most factors the current level, not the historic level, of effect from a given factor is that which we anticipate in the foreseeable future. Hence, rather than repeat what we presented in Chapter 4, we refer to, and summarize that information in this section. We point out those cases where available information increases our uncertainty about the likelihood that the future level and/or kinds of effect from a given factor are likely to be similar to the current level or where we have increased uncertainty about the potential effect of the factor than we had at the time of the threats assessment in the Recovery Plan.

As the subject of this consultation is research disturbance during directed Seller sea lion and northern fur sea research and is, thus, considered in the effects section of this biological opinion, we do not cover that aspect of research disturbance in the cumulative effects section.

6.2 Summary of Factors that Pose an Impediment to Recovery

The Recovery Plan provided threats assessment related to both populations of Steller sea lions. In the threats assessment, a threat was defined (NMFS 2008a) as "…any factor (natural or human related) which represents a substantial impediment to recovery…" including natural factors.

For the western DPS, the Recovery Plan threats assessment concluded that the following threats pose a relatively minor threat to recovery: (1) Alaska Native subsistence harvest, (2) illegal shooting, (3) entanglement in marine debris, (4) disease, and (5) disturbance from vessel traffic and scientific research. The threats assessment also concluded that "…considerable uncertainty remains about the magnitude and likelihood of the following potential threats to the recovery of the western DPS (relative impacts in parenthesis): competition with fisheries (potentially high), environmental variability (potentially high), incidental take by fisheries (low), toxic substances (medium) and predation by killer whales (potentially high)." We have excerpted Table IV-1 from the Recovery Plan as Table 6.1 of this document.

We have increased uncertainty and hence increased concern about the level of threat posed by some factors compared to our understanding at the time of the Recovery Plan. Those factors are: disease, entanglement, Alaska native subsistence hunting (in the central Aleutians), and pollution. Since the time of the Recovery Plan, phocine distemper virus has been confirmed (Goldstein et al. 2009) to now infect sea otters in parts of the North Pacific within the range of the Steller sea lion. This increases our concern and uncertainty about the potential risk of disease to the recovery of the western DPS compared to our uncertainty at the time of the finalization of the Recovery Plan in early 2008. New unpublished, but available data has emerged from studies by ADF&G that indicates current published estimates of entanglement in, and ingestion of, marine debris may be underestimates of actual levels. Thus, we have increased concern and uncertainty about this threat. Lastly, the level of subsistence take at Atka in the central Aleutians is high relative to the abundance of sea lions in the area and overall non-pups counts at Atka were done sharply in the 2008 count. Thus, we have concern that subsistence take in this local area could be impeding recovery and contributing to the downward trend in the central Aleutians as a whole. We also note that since the writing of the Recovery Plan, plans for State of Alaska oil and gas leasing and lease sales in areas north of the Alaska Peninsula have occurred. This increases our uncertainty about the threat posed by pollution.

The threats assessment in the 2008 Recovery Plan identified no threats to continued recovery for the eastern DPS. In the Recovery Plan NMFS (2008a) concluded that: "Although several factors affecting the western DPS also affect the eastern DPS (e.g., environmental variability, killer whale predation, toxic substances, disturbance, shooting), these threats do not appear to be at a level sufficient to keep this population from continuing to recover, given the long term sustained growth of the population as a whole. However, concerns exist regarding global climate change and the potential for the southern part of the range (i.e., California) to be adversely affected." Since the Recovery Plan was finalized additional information has become available from the ADF&G that indicates that the incidence of entanglement of Steller sea lions in the eastern DPS may occur with greater frequency than had been documented at the time of finalization of the Recovery Plan. Additionally, a disease (phocine distemper virus) that is likely novel to the North Pacific has now been detected in another species of marine mammal (sea otters) in multiple portions of the range in which individuals from this Steller sea lion population are known to feed and haul out. Hence, there is new information that increases our uncertainty about potential threats to this population. However, at present, there is not information indicating recovery is being impeded by these factors.

Table 6.1 Factors identified as threats to the recovery of the western DPS of Steller sea lion in the next 5 years (2006-2010), and the information used as evidence to rank the relative impact of those threats as High, Medium, or Low. The mechanism of each threat either top-down (threats that kill sea lions independent of the capacity of the environment to support them) or bottom-up (threats that affect the physical condition of sea lions due to the inability of their environment to support them); each of these can be either direct (directly reduces survivorship of individual sea lions) or indirect (indirectly reduces body condition and subsequently reproduction and survival) (see NRC 2003 for a detailed discussion of food webs and top-down/bottom-up control). Reproduced from Table IV-1 in the 2008 Recovery Plan, NMFS 2008a)

Threat	**Mechanism**	**Most Vulnerable Age-Class**	**Frequency of Threat Occurring**	**Uncertainty**	**Relative Impact to Recovery**
Environmental Variability	Bottom-up	Adult Females & Juveniles	High	High	Potentially High
Competition with Fisheries	Bottom-up	Adult Females & Juveniles	High	High	Potentially High
Killer Whales	Top-down	Pups & Juveniles	High	High	Potentially High
Toxic Substances	Top-down or Bottom-up	Adult Females & Pups	High	High	Medium
Incidental Take by Fisheries	Top-down	Juveniles	Medium	Medium	Low
Alaska Native Subsistence Harvest	Top-down	Adult & Juvenile Males	Medium	Low	Low[1]
Illegal Shooting	Top-down	Non-pups	Low	Medium	Low
Entanglement in Marine Debris	Top-down	Juveniles	Medium	Medium	Low[2]
Disease and Parasitism	Top-down or Bottom-up	Adult Females & Pups	High	Medium[3]	Low
Disturbance from Vessel Traffic and Tourism	Top-down or Bottom-up	Pups	Medium	Medium	Low

[1]- But see discussion below regarding the potential for subsistence harvest in a few locations to impede recovery in those areas and/or contribute to a continuing downward trend

[2] – But see discussion about new information indicating rates of entanglement in at least some areas may presently be underestimated

[3] – But see discussion about new information indicating that phocine distemper virus is now present in another marine mammal within parts of the range of the western DPS.

6.3 Subsistence Harvest

We provided information about past and current levels of subsistence harvest of Steller sea lions by Alaska natives in the Baseline section. We expect subsistence harvest to continue into the foreseeable future. ADFG and the Alaska Native Harbor Seal Commission have recently been collaborating to document subsistence harvest through the use of a retrospective survey undertaken in a large number of villages in coastal Alaska. As noted above, documented annual take of Steller sea lions by subsistence hunters between 1998 and 2007 ranged from 171-218, with 217 animals reported taken in 2007 (Wolfe et al. 2009). Confidence intervals around these estimates are large (e.g., in 2007, the 95% confidence interval was 147-324. The vast majority of the reported takes come from just a few locations located within the range of the western DPS, including the Pribilofs, the central Aleutians, and Prince William Sound. Patterns over the past years have been variable with levels of take increasing in some areas (e.g. Tatiklek) and decreasing in others. Thus, it is hard to predict future pattern.

The reported take levels associated with subsistence harvest in the eastern DPS are low (e.g., 6.1 with an upper estimate of 9.5 in 2007) and, as concluded in the Recovery Plan, should not impede recovery of that DPS.

Levels of harvest in a few locations in the western DPS (e.g., Atka, where the total take estimate for 2007 was 54, with an upper range estimate of 87.2) could contribute substantially to the already downward trend in the local area and contribute to the overall downward trend in the subarea. Non-pups counts at North Cape on Atka fell drastically in the last 4 years (2000: 76; 2002: 224; 2004:383; 2006: 279; 2007: 140; 2008:34) and have risen slightly at Cape Korovin (2000:12; 2002:1; 2004: 4; 2006: 0; 2007: 30; 2008:39). As we concluded in the 2007 Opinion, the overall future impact of the subsistence harvest on the western population will be determined by the number of animals taken, their sex and age class, and the location where they are taken.

6.4 Entanglement in Marine Debris

As noted above, and in the Baseline section, in the Recovery Plan NMFS (2008a) concluded that the threat to Steller sea lions from entanglement was low. Levels of entanglement captured in the stranding database are low. However, unpublished information collected during resighting trips by ADF&G indicate that only a small percentage of the entanglements, at least in Southeast Alaska, are reflected in the currently available entanglement estimates. During an eight year study in Southeast Alaska and British Columbia researchers observed 388 Steller sea lions were observed that were either entangled or that had ingested fishing gear. About half of the sea lions had some kind of neck entanglement whereas about half of the animals had ingested either commercial or sport lures. Over half of the neck entanglements observed in Alaska were plastic packing bands. Other types of entanglements included lures in their mouths. About 80% of the ingested fishing gear came from salmon fisheries. Other swallowed gear included longline gear, monofilament line, etc. These observations indicate that current estimates of entanglement, including entanglements that are known to have caused death and those that almost certainly caused death or serious injury, may be serious underestimates. Thus, we acknowledge increased uncertainty about the threat posed by entanglements based on the ADF&G observations (lay report “Entanglement of Steller Sea Lions in Marine Debris: Identifying Causes and Finding Solutions”, available in video form at http://www.multimedia.adfg.alaska.gov). At present, we do not have information that would suggest current rates of entanglement are likely to increase or decrease in the foreseeable future.

6.5 State Managed Commercial Fisheries

State managed fisheries may affect sea lions through both direct and indirect mechanisms. Direct impacts include sea lions killed inadvertently in trawls, seines, or gill nets. State-managed fisheries may also cause nonlethal effects due to disturbance of sea lion haulouts, vessel noise, entanglement in nets, and preclusion from foraging areas due to active fishing vessels and gear. Indirect impacts may also occur due to competition between the fisheries and sea lions for common prey. For example, state managed fisheries can compete with sea lions for walleye pollock, Pacific salmon, Pacific cod, and Pacific herring. All of these species are consumed with relatively high frequency by the western population of sea lions and are the focus of state managed fisheries. State managed groundfish harvesting can cause dense schools of fish to scatter, reducing sea lion prey density and decreasing the value of foraging habitat. Short term intensive fishing effort targeted on spawning aggregations of herring and on high densities of salmon at stream or river outlets may decrease the opportunities for sea lions to forage efficiently. As a result, individual sea lions may have to expend more time and energy to consume the same quantity of fish. State managed fisheries occur near shore, often in areas within Steller sea lion critical habitat and take high value and often highly ephemeral prey species. With regard to direct effects, state managed fisheries are likely to continue to account for some annual mortality. Based on data collected in 1990-1991, Angliss and Allen (2008) reported a mean annual mortality of (14.5 CV = 1.0) in Prince William Sound driftnet fisheries and 0.6 for the Alaska salmon troll fishery. However, as noted in the section on entanglements, State managed salmon fisheries may be associated with high levels of previously undocumented entanglements and ingestion of lures. There are no available estimates of the frequency or severity of nonlethal takes in state managed fisheries, but presumably nonlethal takes will continue at current levels. Regarding indirect effects, NMFS concludes based on available information that state managed fisheries for pollock, cod, herring, and salmon are likely to continue to compete for fish with foraging Steller sea lions. Such competition for fish may have significant effects on the ability of Steller sea lions to utilize these high values, and in some cases, seasonally important but highly ephemeral, prey in near shore area. Nearshore areas are of high importance to Steller sea lions, including, but not limited to, foraging pups and lactating females. These interactions may contribute to nutritional stress for sea lions, and may reduce the value of the marine portions of designated sea lion critical habitat. State managed fisheries will continue to reduce the abundance of preferred sea lion prey within these marine foraging areas and may alter the distribution of certain prey resources in ways that reduce the foraging effectiveness of sea lions. Therefore, state managed fisheries (particularly for herring, salmon, and groundfish) may, in some areas, impede or slow recovery of the western population of Steller sea lions and may reduce the prospects for survival and recovery. More data on the foraging habits of Steller sea lions from research in key geographic areas could aid our understanding of where and when these effects might be most important.

6.6 Sport and Subsistence/Tribal Fisheries

As we stated in the 2007 Opinion, we expect that sport and tribal/subsistence fisheries have an incremental effect on listed Steller sea lions relative to that in commercial fisheries. Alaska’s sport fishery harvests about 1 percent (4,000 mt) and subsistence fishery harvests 2 percent (8,000 mt) of the annual State of Alaska total fish harvests, while the commercial fisheries accounted for 97 percent (900,000 mt) of the annual harvest in 1998. Impacts are likely limited to minor removals of the potential foraging base, but in such small volumes that we expect only incremental adverse effects, if any. Effects due to lost gear and potential entanglements and ingestion are documented but we have uncertainty about the magnitude of the current levels (see discussion of entanglements above). Sea lions can also be disturbed in key areas by the sport fishermen and be attracted to sport-fishery related cleaning areas in harbors. Sport and subsistence fisheries are expected to continue into the foreseeable future throughout the action area and may increase in the future as tourism and population increases.

6.7 State Oil and Gas Leasing

Oil and gas leasing on state lands in areas near Steller sea lion habitat and in Alaska state waters is likely to occur in the future. Such leasing and exploration has occurred for a long period of time. However, given changes in energy prices and increasing demand, it is also likely that more development and production will also occur.

At present, a number of active fields produce oil in Cook Inlet, all of which is processed at the refinery at Nikiski on the Kenai Peninsula. Estimated oil reserves in Cook Inlet are 72 million barrels of oil.

Currently there are additional lease sales planned for the next five years (State of Alaska Oil and Gas Leasing Program (available at www.dog.dnr.state.ak). In areas where Steller sea lions could be affected, oil and gas lease sales are currently scheduled for Cook Inlet (annual sales 2009-2013) and the Alaska Peninsula (annual sales 2009-2013). A lease sale for the Alaska Peninsula areas was scheduled for May 2009. The State of Alaska's best interest finding (available at the website given above) for this sale was to offer all available state acreage in the Alaska Peninsula Areawide Oil and Gas Lease Sales. This area includes waters to the east of Steller sea lion critical habitat. Oil spills, noise, and vessel traffic associated with this oil and gas activity could adversely affect sea lions and the critical habitat in ways previous discussed in the baseline. The exact nature of any effects would be site and scenario specific. Development scenarios provided by Shell Oil during public forums in the Bristol Bay/Alaska Peninsula area in recent years showed development of waters to the north of the Alaska Peninsula with pipelines across the peninsula to a LNG plant in. Under this proposed scenario (available at http://www.akrdc.org/membership/events/breakfast/0708/nady.pdf) tankering would occur through Steller sea lion critical habitat north and northeast of Sand Point. In Cook Inlet, the State proposes to offer leases throughout the inlet from the northernmost areas south to approximately Anchor Point on the southeast and areas outside of Cook Inlet that would fall within the action area. There are active leases along the Kenai Peninsula coast as far south as approximately Ninilchik.

6.8 Vessel and Aircraft Activity

Our conclusions about potential cumulative effects form vessel and aircraft activity are similar to those stated in previous Biological Opinions. Disturbance from vessel and aircraft traffic has variable effects on sea lions ranging from no reaction at all to temporary departure from haulouts and rookeries and even abandonment of haulouts and rookeries (Johnson et al. 1989; Calkins and Pitcher 1982; Thorsteinson and Lensink 1962; Kenyon 1962). These effects stem primarily from noise emanating from cruise ships, ferries, small boats, and aircraft. The consequences of such disturbance to the overall sea lion population are difficult to measure in part because most instances of such disturbance are not documented or studied. Disturbance may have contributed to or exacerbated the decline of Steller sea lions, although it likely has not been a major factor in the decline. NMFS has taken steps to reduce disturbance around rookeries by the placement of 3nm no-entry zones. NMFS expects disturbance from vessels and aircraft to continue in the future at levels comparable to or, more likely greater than, the present.

6.9 Population Growth

Through the action area, the potential foreseeable impact from human population growth rate varies greatly. Alaska has the lowest population density of all of the states in the United States and many areas of the state adjacent to Steller sea lion habitat (e.g., the western Aleutians) do not have many permanent year-round settlements present. Other coastal areas adjacent to Steller sea lion habitat, such as parts of southern and central California, are densely populated.

In general, population density is greater in the range of the eastern DPS than in the western DPS. Although Alaska's population has increased by almost 50 percent in the past 20 years, most of that increase has occurred in Anchorage and Fairbanks. Outside of Anchorage, the largest populations occur on the Kenai Peninsula, the Island of Kodiak, Fairbanks, Juneau, Bethel, and in the Valdez - Cordova region. Outside of Anchorage, few of the cities, towns, and villages would be considered urbanized. As we noted in the 2007 Opinion, within Alaska, rural populations may increase or decrease based on their ability to exploit resources such as fisheries and secure necessities to live in these remote areas. Many rural villages have experienced population declines, mostly in the Aleutians. To bolster these communities, the state has begun to develop local fisheries. For example, the state has implemented a local Adak Pacific cod fishery where vessels fishing under the Federal TAC would be excluded by size in order to allow the local small boat fleet to harvest the TAC in that area. This effectively takes management control away from the Federal government, concentrates catch inside state waters (out to 3 miles), and focuses the dependence of specific coastal communities on fisheries. This system may put severe pressure on fishery managers in the future to enact regulations that provide for near-shore fisheries, leading to conflicts with measures to limit adverse impacts to critical habitat for sea lions. NMFS has also recently become aware of plans by the BLM to transfer large amounts of federal land in the Aleutians into ownership by Alaska Natives under provisions of ANCSA. While this is a future federal action, we discuss it here because it is not clear that the BLM will consult under Section 7 on this action. If this land transfer occurs, land in the Aleutians (currently primarily on FWS refuge land) including land adjacent to and possibly within Steller sea lion critical habitat will go out of federal ownership into private ownership. Some of the areas are being subdivided, but the future intended uses of these areas are not clear, and, hence it is not possible to predict impacts.

In general, as the human population increases, becomes more dense at a given coastal location, and settles into previously unsettled areas (as is expected particularly around major cities), the risk of interactions between people and listed species increases. Sea lions can be affected by nearby human settlements in many ways including increases in: disturbance and potential loss of suitable habitat (e.g., due to increasing ship. boat and air traffic; nearby roads); pollution (due to run-off, sewage and gray-water discharge, industrial discharge, shipping accidents; in some areas, increased oil and gas spills offshore; disease; coastal noise and displacement due to construction; and potentially increased harvests (in Alaska). Sea lions also sometimes utilize human structures and/or begin to interact with humans in harbors where they may haul out and/or pursue accessible fish waste. This type of interact can result in risks to sea lions (e.g., some become aggressive and may be hazed). .In general, as the size of human communities increases, there is an accompanying increase in habitat alterations and impacts on landscapes and biota. As areas are modified for the construction of housing, roads, commercial facilities, and other infrastructure, native plants and animals are displaced and waste disposal needs increase.

Steller sea lions typically haul out on offshore (and occasionally onshore) rocks and islands; however, in some areas they have adopted man made structures (e.g., jetties) as haulout habitat.

The south jetty at the mouth of the Columbia River is such a location and is routinely used by several hundred Steller sea lions in addition to similar numbers of California sea lions. Steller sea lions also occasionally forage in estuaries and the mouths of rivers along the west coast. Many of these estuary areas are also developed as marine terminals for shipping and boat moorage. The lower river reaches and estuaries are kept in navigable condition by maintenance dredging. Noise from dredge operations may cause temporary behavioral avoidance by Steller sea lions in the vicinity of the activity.

6.10 Climate Change, other Environmental Variability, and Ocean Acidification

We discuss these factors in some detail in the baseline section. It is clear from recent reports (e.g., IPCC 2007a) that global warming is likely to continue for some time regardless of international public policy related to decreases in greenhouse gas emissions. However, the magnitude and rate of change is expected to be influenced by such emissions. Thus, we have uncertainty about how rapidly change will occur, what the upper limit of warming in the North Pacific will be, what specific effects this warming will have on basic oceanographic processes (such as currents, areas of upwelling, and primary production), and Steller sea lion prey distribution and abundance). Sea lion distribution may shift northward. The distribution and abundance of key prey species could be affected. Prey species may be simultaneously affected by global warming, natural climate variability, ocean acidification, and fishing removals with uncertain, but not likely positive results. As noted in the Baseline section, with regards to ocean acidification only, the Interacademy Panel on International Issues (IAP 2009) stated that:

> "The high CO_2 waters in polar and upwelling regions such as the eastern Pacific and Bering Sea for example, will experience low pH more rapidly than other regions…The ocean chemistry changes projected will exceed the range of natural variability, which is likely to be too rapid for many species to adapt to. Many coastal animals and groups of phytoplankton and zooplankton may be directly affected with implications for fish, marine mammals and the other groups that depend on them for food…The impacts of these changes on oceanic ecosystems…cannot yet be estimated accurately but they are potentially large…Although some species may benefit, most are adapted to current conditions and the impacts on ocean biological diversity and ecosystem functioning will likely be severe.

Sea level rise threatens terrestrial components of Steller sea lion critical habitat. However, detailed modeling studies are not available to support analysis of how many sites and which sites might be affected first. In some areas, it is likely that sea lions can move higher up the beach. However, the topography in other sites will prevent this.

Overall, we anticipate continuing, probably accelerating, and probably interacting effects from global warming, environmental variability, and ocean acidification on Steller sea lions and their prey. However, data are not sufficient to be able to predict how these factors will affect Steller sea lions in a given area over the foreseeable future.

6.11 Toxic Substances

The threat to Steller sea lions and their critical habitat posed by toxic substances is likely to be similar to, or to rise, from baseline levels. A rise is possible due to projections of worldwide population growth and the release of toxic substances, especially in the developing world, but also in areas of the U.S., Canada, and Russia adjacent to Steller sea lion habitat. Plans to develop oil and gas reserves in the southeastern Bering Sea increase the risk to sea lions from an oil spill. If this activity occurs, shipping and vessel traffic in Steller sea lion habitat will increase, thereby raising both levels of disturbance and risk of the release of toxic substances over baseline levels.

New, but unpublished information presented at the 2009 Marine Science Symposium showing relatively high (at levels where toxic effects ay occur) mercury and methylmercury levels in a relatively high percentage of very young Steller sea lion pups in the western population of Steller sea lions raises concerns about this pollutant (see discussion of potential toxic effects in the baseline section). At present, data are insufficient to know whether our previous conclusions (NMFS 2008) about the threat of contaminants need modified and whether it is likely levels of key contaminants are increasing.

6.12 Disease and Parasitism

NMFS (2008a) concluded that the threat posed by disease and parasitism to the recovery of the western DPS of Steller sea lions was low. We expressed a medium level of uncertainty about this threat. As noted in the baseline section, we have an increased level of concern about the threat to Steller sea lions due to the threat of infectious disease due to documentation by Goldstein et al. (2009) of the presence of phocine distemper virus in sea otters in areas of the Aleutians, the Kodiak Archipelago, and Kachemak Bay. Goldstein et al. (2009) concluded that:

> "These results demonstrate that PDV has been introduced to the North Pacific Ocean since 2000. All Pacific marine mammal species are now at risk for phocine distemper–induced population decreases…Viral nucleic acid in nasal swabs from free-ranging, live-captured otters confirms viral shedding. Therefore, otters are capable of transmitting PDV to conspecifics and other species.
>
> Because the PDV fragment isolated from Alaskan otters is identical to that of the 2002 Atlantic isolate, this virus was likely transmitted to the North Pacific Ocean after the 2002 European epidemic, although it is remotely possible that it may have originated in the North Pacific Ocean during 2000–2002.

Goldstein et al. (2009) speculated that the entry of this virus into North America may have occurred due to global warming. They wrote:

> The decrease in sea ice during the 14 years between these epidemics may have affected movement of Arctic seal populations…This reduction was even more pronounced in 2004 and 2005, years in which PDV was confirmed to have infected sea otters…Ice coverage is at its lowest level during August and September…In 1988 and 2002, the

> PDV epidemic had reached gray and harbor seal populations in the North Sea and Norwegian Sea by August. This sea ice reduction may have altered seal haul-out and migration patterns, resulting in contact between Atlantic, Arctic, and Pacific Ocean species that was not possible in 1988 and the few years afterwards.

If this is indeed the case, the entry of this virus into the North Pacific may be an effect of global warming. Regardless, the virus poses a threat to Steller sea lion populations to which, available evidence indicates the virus is novel. Potential impacts are high. In the Atlantic, this virus has resulted in the deaths of tens of thousands of seals during multiple epidemics.

7 CONCLUSION

7.1 Summary Statement

After reviewing the current status of the endangered western population of Steller sea lions, the threatened eastern population of Steller sea lions, the environmental baseline for the action area, the effects of the proposed research program, and the cumulative effects, it is NMFS' biological opinion that the research program, as proposed, is not likely to jeopardize the continued existence of the endangered western DPS of Steller sea lions or the threatened eastern DPS of Steller sea lions. Critical habitat for this species has been designated for listed Steller sea lions. We conclude that the proposed action is not likely to result in the destruction or adverse modification of that critical habitat.

7.2 Synthesis of Effects

Steller sea lions are protected pursuant to the ESA, as two distinct population segments. Animals that breed on rookeries east of 144° W are part of the eastern DPS, which is listed as threatened under the ESA, and animals west of 144° W are part of the western DPS, which is listed as endangered. The eastern population is slowly increasing. Non-pup abundance in the western population is either stable overall or declining slightly. However, there are still vast areas of the range, particularly in the western and central Aleutians where non-pup counts are steeply down. The 2008 Recovery Plan did not identify any significant threats to the recovery of the eastern population but many threats, some potentially large, still exist for the western population. We have increased uncertainty about some threats, including entanglement in both populations, disease, and contaminants. Subsistence take could potentially contribute to declines and impede recovery in at least one local area. Our full analysis under Section 7 of the effects of groundfish fisheries is ongoing and not available for this opinion. Data on global warming suggest the climate is changing faster that predicted with highly uncertain effects on the marine ecosystems of the North Pacific.

Research is critically needed to provide better information about these and other factors that threaten the recovery of the western DPS of Steller sea lions and may be affecting the eastern DPS. Information from research can help NMFS to formulate research actions to help get Steller sea lions to the point of recovery. Thus, the potential benefits from this proposed action to the recovery of the two Steller sea lion populations are large. **The action under consultation is intended to aid in conservation of the affected species.** NMFS (2009b:1) summarized the purpose for the proposed action as follows:

> “The purpose of conducting research on SSLs and NFSs, as stated in the SSL Recovery Plan (NMFS 2008) and NFS Conservation Plan (NMFS 2007), is to promote the recovery of the species’ populations to levels appropriate to justify removal from ESA listings (in the case of SSLs)…NMFS is the federal agency responsible for management, conservation, and protection of these species. NMFS facilitates research on SSLs and NFSs by awarding grants and issuing permits. This research may yield

information that can be used by NMFS to develop more informed and effective management actions to promote recovery and conservation of SSLs and NFSs.

Thus, it is important to acknowledge that this action differs from typical actions (e.g., oil and gas leasing, harbor construction, naval exercises, etc.) on which NMFS consults because it is being undertaken to help conserve the species. The action on which we are consulting here is an action that, in general terms (research) is envisioned in the ESA as an integral part of the definition of the terms “conserve”, “conserving” and “conservation” of a species. It is recognized by the ESA and by NMFS (e.g., in the 1992 and the 2008 Steller Sea Lion Recovery Plans) that research is needed to help us formulate management actions to help these species recover. However, not all research would necessarily aid in the conservation of Steller sea lions. It is, therefore, incumbent upon NMFS to ensure that the purpose and need for the proposed action (as described above) is actually met and that the issuance criteria of the ESA and the MMPA are complied with to ensure that the research results provide such a benefit to the conservation of Steller sea lions. Based on our review of issuance criteria and on the Policy and Guidance Document, we believe that this standard will be met.

There are potential adverse effects risks associated with the permitted activities to both the eastern and western populations of Steller sea lions. The research could cause disturbance which could result in sublethal or even lethal impacts to individuals. Other research activities, such as capture, restraint, anesthesia, sampling, instrumenting, etc., all have potential adverse effects.

NMFS (2009) recently developed a Policy and Guidance Document to establish policy guidance to promote consistent compliance with the PEIS and the National Environmental Policy Act (NEPA) for:

- reviewing permit applications and reports
- coordinating research
- monitoring effects of research
- monitoring effectiveness of research (in contributing to purpose and need in PEIS)

The Policy and Guidance Document is responsive to concerns raised in the 2007 Biological Opinion in which NMFS (2007a) expressed uncertainty, and a certain amount of unease about that uncertainty, regarding whether the NMFS Permits Division has sufficient structure and consistency in evaluation of permits to ensure adherence to the issuance criteria under the ESA and the MMPA. NMFS (2007a:7) wrote that:

> “After conducting a critical examination of the Steller sea lion and Northern fur seal research program, the decision-making process used to authorize research permits, and the general classes of activities the program would authorize, NMFS determined that the program would benefit from a stronger, clearly articulated decision framework that promotes a reasoned way to balance competing interests and competing risks to ensure that research activities authorized under the program would not permit an exemption to the protective restrictions imposed by the Marine Mammal Protection Act and the Endangered Species Act for a particular study or investigation *except* when a particular study or investigation would be expected to contribute to the conservation and recovery of the species.”

Hence, we interpret this Policy and Guidance document not as modifying the scope of *potential* activities that will be considered for permitting, as described in the FPEIS under the Preferred Alternative but in providing detail as to how permitting of Steller sea lion and northern fur seal research would actually be implemented under that Preferred Alternative to ensure compliance with the ESA and the MMPA. It clarifies and reiterates the specific findings the MMPA and ESA require NMFS to make prior to the issuance of a research permit on an ESA-listed marine mammal relative to the purposes and the policies of those statutes. It clarifies processes for processing permits and suspending permitted activities when a permit holder violates the ESA, MMPA, the permit, or the implementing regulations of either act. It specifies a clearly articulated decision framework that NMFS will use in the application review process to promote conservation and recovery of the species. This document also specifies limitations to total estimated research-related mortality that will be permitted. It specifies that requirements will be placed on permits related to monitoring the effects of research. Lastly, as detailed in the section on the Description of the Action, the Policy and Guidance Document does modify the implementation of the Preferred Alternative in another important way: it lowers the acceptable upper cap on research-related mortality to 10% of PBR for the foreseeable future. NMFS (2009a) wrote: "Until there is sufficient data or information to develop a more robust mortality risk assessment method, NMFS will limit research-related mortality to the levels permitted in 2007: below 10% of potential biological removal for each stock. These mortalities will be allocated among research applicants based on the types of research activities and numbers of takes requested."

There is a requirement for prompt notification and review in the case of serious injury or death of a Steller sea lion during research activities. To the extent possible, measures have been put in place to minimize the adverse impact of permitted research and to address the inadvertent impacts.

There are substantial potential benefits to Steller sea lion conservation from implementing a program that can fully accommodate all recovery actions in the 2008 Recovery Plan. There is risk to the population if research needed to guide recovery is not undertaken. NMFS has in place an improved framework for ensuring positive net benefit of research to species and considerable discretion to impose additional conditions on permits if necessary to minimize impacts to Steller sea lions. The evidence before us indicates that while there are potential adverse effects, these effects are manageable. We conclude that the probable net result of the affected action, if implemented consistent with the Policy and Guidance Document and the issuance criteria under the ESA and the MMPA, is positive.

We conclude that the proposed action does not appreciably affect prey availability within aquatic areas of critical habitat, it does not affect air quality, and it does not affect substrate or exposure to wind and waves. However, this action has effects on the extent and type of human activities and disturbance in the region. Nearly all of the elements in the proposed action, with the exception of activities at the Alaska SeaLife Center increase the extent and type of human activities and disturbance in the region of terrestrial critical habitat. However, this change is highly ephemeral. Such disturbance can last about 5 minutes (in the case of aerial surveys) or up to 12 hours (for on-site work involving many procedures on the same animals. Available date (e.g., Fritz et al. 2008) indicate this temporary increase in the extent and type of human activities does not affect the ability of the habitat to serve its conservation value for either DPS of Steller sea lions. However, NMFS should consider imposition of limits on the length of time researchers can stay on a rookery or haulout and the number of trips during a year to the haulout. This is within NMFS' discretion. These activities could have adverse effects on critical habitat if researchers were to contaminate the terrestrial habitat or nearby waters. This could occur if human garbage or human waste was deposited on the terrestrial habitat or in the water. NMFS should ensure that all human waste and garbage are removed from the site. This requirement is within NMFS's discretion and thus, we assume, for the purposes of the analysis, would be imposed as part of terms and conditions on permits to minimize the potential for adverse effects.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS (50 C.F.R. § 222.102) as "…means an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering".

Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

AMOUNT OR EXTENT OF TAKE ANTICIPATED

The proposed action requests directed, not incidental, take of threatened and endangered Steller sea lions in waters off Alaska, Washington, Oregon and California. NMFS does not expect any other listed species to be taken incidentally to this research.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

Below, we provide conservation recommendations designed to accomplish all three of these objectives.

1) Minimize the Potential for Research-Related Human-Mediated Transfer of Disease to Steller Sea Lions

A) Develop Protocols to Reduce Potential for disease Introduction and/Transfer.--.The AKR PRD, in collaboration with the AFSC, ADF&G, the Permits Division and federal and non-federal disease experts should, within the next 18 months, undertake or fund the following: a) a review of measures currently being implemented to reduce the potential for inadvertent human-mediated transfer of disease between individual Steller sea lions, different rookeries and haulouts, and between captive facilities and field sites during NOAA funded or permitted research activities; and b) the development of a protocol that will be required in permits for Steller sea lion and Northern fur seal research to minimize the potential for such disease transfer or introduction.

B) Stipulate Interim Steps to Reduce Potential for Disease Transfer.--During the period when the aforementioned protocol is being developed, we recommend that all permits for directed research on Steller lions in which contact with SSLs and humans could occur, or in which humans are going to Steller sea lion rookery and/or haulouts, stipulate that researchers shall take steps to reduce the potential for human-mediated transfer, introduction, or redistribution of disease pathogens between captive facilities and field sites, between animals at different field locations, between individual animals, and between groups of captive animals. We recommend that, at a minimum, the following be included in such measures: Clean coveralls or clothing must be worn at each study site. Shoes and other foot gear must be disinfected before and after working at a Steller sea lion site. To the extent feasible given the field conditions, equipment, such as nets, should be disinfected between individual rookeries or haulouts. Measures will be taken to avoid exposure of Steller sea lions to human waste.

We make these related recommendations because measures to reduce disease introduction are an important component of overall measures to reduce potential adverse effects from research. As phocine distemper virus (PDV) has now been confirmed (Goldstein et al. 2009) to infect sea otters in areas of the range of the Steller sea lion in Alaska, we consider the development of such a protocol to minimize the potential for human-mediated disease transfer to be a high priority. If PDV is detected in Steller sea lions, Section 7 consultation should be reinitiated to determine if the proposed levels and modes of research are appropriate.

2) Strengthen and Make More Transparent the Recovery Value of Permitted and Funded Research on Steller Sea Lions and Northern Fur Seals

A) Develop a Research Prioritization and Implementation Plan for Steller Sea Lions.**--** In order to improve the basis of NMFS decisions about whether or not to fund and/or to permit a proposed research project (or a specific task within that project) the NMFS Alaska Region PRD, in collaboration with the AFSC, should initiate the development of a Research Implementation Plan for Steller Sea Lion Research to further prioritize, integrate, and coordinate research tasks identified in the 2009 Recovery Plan and to help identify those research methodologies most likely to result in the successful implementation of those tasks with the lowest potential adverse effect on Steller sea lions . NMFS should consider the formation of a Research Implementation Plan Team, consisting of both federal, state, and non-agency scientists to assist it in the development of this plan. Once developed, the priorities in this plan should be used as a point of reference in the allocation of federal funds, comments on proposal and permit reviews, and, in cases where the potential level of take from all requested entities would exceed 15% of PBR, to aid in determinations about the allocation of take for different research tasks. If such a team is formed, the team should also assist NMFS in the identification of focused reviews or workshops (similar to workshops convened in the late 1990s) needed to enable highly focused review of information, methodologies or priorities on more specific topics (e.g., evaluation of fishery effects on Steller sea lions or the need for disease surveillance).

This measure would likely increase the average value of permitted Steller sea lion to recovery efforts realized from permitted and funded research.

This measure would also be responsive to the following comment in Section II from the Independent Review Panel in their final report (available as Appendix C of the National Marine Fisheries Service Policy and Guidance for Implementation of the Steller Sea Lion and Northern Fur Seal Research Permits and Grants Programs…, at http://www.nmfs.noaa.gov/pr/pdfs/permits/ssl_eis_policy.pdf), a section entitled "Overarching Considerations For Prioritizing Research Needs And Issuing Research Permits":

> "With regard to issuance of permits for scientific research, read together these sections" (Sections 3 and 10 of the ESA) "say that NMFS may issue permits for scientific research on ESA-listed species if it finds that such permits will further the recovery of the species. It is therefore obvious that there needs to be a transparent, effective, and timely mechanism for identifying research essential for conservation and recovery, which should form the backbone of an RPEP."

B) Require Researchers Demonstrate Recovery Link Of Their Research In Their Permit And Proposal Applications.--The Permits Division of the AKR Grants Office should request that, if researchers have not already done so, for all major tasks in their proposed research on Steller sea lions for which a permit is sought, the investigators identify the recovery tasks within the 2008 SSLRP which their proposed research would address and identify the priority assigned to that task in the SSLRP. If such linkage cannot be made, we recommend that PR1 request that the researchers make a brief, but compelling case as to the recovery value of the proposed research. If a case cannot be made that research will be valuable for the recovery of

Steller sea lions, or if researchers do not make such a case, the Permits Division should not permit that research.

In order to provide a well-documented record regarding the linkage between permitted research that may adversely affect Steller sea lions and the need that such research have overall positive value to the conservation of the listed species, the Alaska Region PRD, which has the agency lead for the implementation of recovery actions on Steller sea lions, should provide an explicit opinion in its review of all permit applications on SSLs and Northern fur seals (if affects are likely on SSLs) as to whether the proposed research is likely to have such value to Steller sea lions conservation.

These recommendations are both offered to reduce the likelihood that NMFS would permit a research task that could have adverse effects on the species but is not likely to provide information of high enough value to recovery to result in a high net value of the research to the conservation of Steller sea lions.

C) Peer Review.--Consistent with a recommendation made to NMFS by the Independent Review Panel, proposals or study designs of projects for which the investigators are seeking either NMFS funding and/or permits for research on Steller sea lions should be peer-reviewed to ensure the scientific validity of the proposed study. This requirement would help mitigate the overall affect of research on Steller sea lions by improving the likelihood that permitted and funded research will provide positive overall net value to the recovery of Steller sea lions. It would also reduce the likelihood that NMFS would permit a research task that could have adverse effects on the species but is not likely to provide information of high enough value to Steller sea lion conservation to result in an overall positive net value of the research to Steller sea lions. This requirement could occur at any stage of the process, but is probably most reasonable at the proposal for funding phase

D) Ensure Knowledge of, and Compliance, with Issuance Criteria.--Consistent with a recommendation of the Independent Review Panel, NMFS should ensure that permitted research complies with all issuance criteria of the ESA, MMPA, and AWA. In order to build a transparent record, applications for funding and for permits should address these criteria explicitly.

E) Require Participation in Research Coordination Meeting.-- All Principal Investigators (or their representative) should be required to attend annual Steller sea lion coordination meetings. Such coordination meetings should be co-hosted by the AFSC NMML and the AKR PRD.

The aforementioned conservation measures are recommended because research on ESA-listed species, especially research that can have adverse effects on individuals, should be likely to have an overall positive value to the conservation of the listed species. Thus, recovery value needs to be maximized and adverse effects need to be minimized. These conservation recommendations are responsive to comments in the final report from the Independent Review Panel including the following:

> "The research and monitoring needed to meet the management needs should be the research and monitoring that has been identified in the recovery plan as essential."
>
> "The research should be coordinated by NMFS, the responsible agency, to ensure that permitted research does match up with the research needs identified in the recovery plan, and to ensure that the methods and protocols proposed will get the job done, minimize impact within that constraint, and pose a risk that is more than compensated by the expected conservation utility of the expected results."

3) Implement Practices to Better Understand and to Minimize Adverse Effects on SSLs from NOAA Fisheries Funded and Permitted Research

A) <u>Strengthen the Rigor And Transparency of the Monitoring of the Effects Of Research</u>.—In cases of NMFS-funded or NMFS permitted research, annual and final reports to both the Permits Division and to the AKR grants office need to provide information sufficient to ensure confidence in conclusions about level of adverse effects that underlies related conclusions about the net overall conservation value of that research. Permit reports need to provide sufficient detail that readers can clearly understand both the estimated and documented levels of different categories of take (e.g., harassment or lethal take) and the basis for conclusions about such take (e.g., a description of all monitoring that occurred). This process of reporting and estimating take needs to be transparent and complete. Failure to submit complete annual and/or final reports should result in the suspension of Steller sea lion or Northern fur seal research permits until reports are received and accepted. The permit office should clarify the need for a clear and complete description of a research program's design for monitoring potential research effects so that it is transparent what we know and what we can't know (e.g., because circumstances, site logistics, etc., do not permit certain types of monitoring). NMFS should require more detail in annual and final reports to ensure that permit holders identify variables meaningful to evaluating research related risks. We recommend that the Permits Division consider the posting of annual reports on their website (as it does for reports on activities conducted under IHAs).

B) <u>Work to Develop Best Practice Protocols for Key Research Tasks</u>.—NMFS AKR, in collaboration with the AFSC, ADF&G, and other entities actively undertaking Steller sea lion research should work towards the development of written protocols (where appropriate) to describe methodologies for undertaking key field tasks on Steller sea lions in such a manner as to minimize adverse effects from those activities and yet result in high quality information to address the particular research issue. These protocols should be periodically updated with new information.

<u>B) Ensure Lethal Taking is a Measure of Last Resort and Used to Obtain Information of Exceptionally High Value to the Conservation of Steller Sea Lions</u>

Full implementation of the Preferred Alternative would permit NMFS to issue permits for the intentional lethal take of Steller sea lions during research activities. Since Steller sea lions are listed under the Endangered Species Act and protected under the Marine Mammal Protection

Act, and especially since the western DPS of Steller sea lions is not currently recovering, such intentional lethal taking of either DPS should be extraordinary. Currently, provisions of the MMPA (16 U.S.C 1374 Sec. 104(c)(3)(B) state that:

> "No permit issued for purposes of scientific research shall authorize the lethal taking of a marine mammal unless the applicant demonstrates that a nonlethal method of conducting the research is not feasible. The Secretary shall not issue a permit for research which involves lethal taking of a marine mammal from a species or stock that is depleted, unless the Secretary determines that the results of such research will directly benefit that species or stock, or that such research fulfills a critically important research need. "

If they have not already done so, the Permits Division should develop specific procedures to evaluate permits for intentional lethal take of Steller sea lions to ensure that all of the aforementioned criteria are met before a permit could be issued. If a permit request is received for intentional lethal take, the applicant should have to show that the proposed research addressed a high priority recovery task, provide compelling evidence that the net effect of the action on Steller sea lion conservation is likely to be positive, and provide compelling evidence that reasonable alternative non-lethal methods have already been tried using the best available techniques, but were not feasible. We recommend that any applications for intentional lethal take for Steller sea lions be subjected to rigorous and transparent independent peer review before approval and that the Permits Division request affirmation of the AKR PRD as to their concurrence as to the overall net value of the particular research to recovery.

4) Improve Information about the Baseline and Potential Cumulative Effects of Steller Sea Lions

NMFS should take steps to improve the underlying information base related to potential existing and cumulative effects of anthropogenic actions on Steller sea lions and their critical habitat. :

A) The Permits Division should require all permittees who are undertaking field research on Steller sea lions and Northern Fur Seals to record all observations of entangled sea lions or sea lions with gear or other artificial, human made objects l(e.g., hooks or lures) lodged in their mouths or other parts of their bodies. The Permits Division should work with the AKR stranding coordinator to determine the exact information that should be collected. However, at a minimum, in addition to information about the location, date, age and sex of Steller sea lion that is entangled, the permittee should record information about the kind of material the animal is entangled in and the extent of wounding caused by the entanglement. Permittees should attempt to obtain at least one photograph documenting the entanglement. All observations of entangled sea lions should be included in annual permit reports. This requirement would strengthen further analyses of potential cumulative impacts on Steller sea lions and thus, help strengthen analyses of the potential significance of research-related effects.

B) On a biennial basis, and in collaboration with the AFSC and the AKR PRD, NMFS Permits Division should re-evaluate the persent of PBR set as the limit for the

C) NMFS AKR PRD should work cooperatively with FWS to determine and mitigate the potential for research conducted on seabirds to inadvertently affect Steller Sea Lions at Bogoslof Island. This recommendation is made to improve the information available for further analyses of potential cumulative impacts on Steller sea lions and thus, help strengthen analyses of the potential significance of research-related effects

5) Adaptively Manage Research on Steller Sea Lions as New Information Becomes Available

NMFS Permits Division should conduct, or fund someone to conduct, an analysis on a yearly basis of the realized estimated lethal, injury and harassment takes from the research conducted within that year, and compare that take with the lethal, injury and harassment take levels that were anticipated at the time of permit review authorization. This annual comparison would permit a transparent evaluation of whether the take levels estimated at the time of permit application and review tend to overestimate the levels of take that will actually occur or whether they tend to underestimate actual levels of takes. If it is found that take levels estimated at the time of permit application review and authorization are underestimating actual take in such a manner that the realized take exceeds or is approaching the limit set as an acceptable level of take, then the authorizations for take should be adjusted downwards. If analysis indicates that take levels are consistently overestimated at the time of application review and research objectives can be met with the authorized levels of actual take, take levels should not be modified, to achieve the minimization of adverse effects, and the high net value to conservation that is ideal in research on endangered species.

Permits for new procedures or the application of methodologies to new age or sex categories of Steller sea lions should be conditional to make permitted actions in year x+1 be informed and modified (if appropriate) by the results from research conducted in year x and in previous years. Such new research should proceed in a staged manner, to first assess feasibility and potential outcomes with a small number of animals in the eastern DPS. Studies can be expanded by both numbers of animals involved and locations in which the research is applied if the early feasibility studies indicate a high success rate with low adverse effects and high expected value to conservation. As stated by the Independent Review Panel,

In order for NMFS Endangered Species Division to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Permits, Conservation and Education Division of the Office of Protected Resources should notify the AKR Protected Resources Division and the NMFS Office of Protected Resources Endangered Species Division of any conservation recommendations they implement in their final action.

REINITIATION NOTICE

This concludes formal consultation on the full implementation of the preferred alternative of the FPEIS on NMFS' Steller sea lion and Northern fur seal research program. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of authorized take is exceeded, NMFS Permits, Conservation and Education Division must immediately request reinitiation of section 7 consultation.

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Appendix A.

2007 Biological Opinion on Steller Sea Lion and
Northern Fur Seal Research Permitting

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Phocine Distemper Virus in Northern Sea Otters in the Pacific Ocean, Alaska, USA

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Phocine distemper virus (PDV) has caused 2 harbor seal epidemics in the Atlantic Ocean, but had never been identified in any Pacific Ocean species. We found that northern sea otters in Alaska are infected with PDV, which has created a disease threat to several sympatric and decreasing Pacific marine mammals.

In northern Europe, phocine distemper virus (PDV) caused 2 epidemics that resulted in 23,000 harbor seal deaths in 1998 and >30,000 deaths in 2002 (*1*). PDV has also been associated with seal deaths on the eastern coast of the United States and Canada, which shows the persistent threat of this virus to Atlantic marine mammal populations (*2*). Serologic surveys before 2000 indicated that Pacific marine mammals had not been exposed to PDV (*3*,*4*), and this virus had never been identified as the cause of illness or death in the North Pacific Ocean. In this region, specifically in Alaska, northern sea otters (*Enhydra lutris kenyoni*) are one of many species that have had population decreases since the 1980s. Steller sea lion (*Eumetopias jubatus*), northern fur seal (*Callorhinus ursinus*), and most recently, harbor seal (*Phoca vitulina*) populations have all decreased (*4*–*6*).

The Study

In 2004 and 2005, strong serologic evidence of exposure to a PDV-like morbillivirus was obtained by serum neutralization for ≈40% (30/77) of live captured sea otters sampled in the eastern Aleutian Islands (Fox Island, South Alaska Peninsula) and Kodiak Archipelago (T. Goldstein et al., unpub. data) (Figure 1, panel A, southwest stock). These captures were part of an investigation into potential causes of a precipitous decrease in the population that resulted in a US Endangered Species Act listing. Although northern sea otters are found along the western coast of Alaska, Canada, and Washington and in the Aleutian Islands, only the southwest stock in Alaska has been decreasing (*9*) (Figure 1, panel A). As little as 50% of the southwest stock remains from the 1980s, and the Aleutian Archipelago population decreased from ≈74,000 to 8,742 sea otters by 2000 (Figure 1, panel A).

In 2006, the US Working Group on Marine Mammal Unusual Mortality Events declared an unusual mortality event for northern sea otters; large numbers of deaths were documented in southcentral Alaska adjacent to the threatened southwest stock (V. Gill, unpub. data) (Figure 1, panel A). Necropsies showed a high prevalence of valvular endocarditis (43%), and septicemia in mature adults associated with various strains of *Streptococcus infantarius* subsp. *coli* (*S. bovis/equinus* complex) and inconsistent intracytoplasmic inclusions were present. However, a primary site of bacterial infection could not be identified in most infected animals, despite this high prevalence of lesions. In humans, *S. bovis* is a major cause of valvular endocarditis and is often associated with preexisting pathologic changes of the colon, underlying disease, and immunosuppression (*10*). This disease is often sporadic and secondary to chronic recurrent bacterial seeding from a primary site of infection or secondary to heart valve abnormalities. The lack of underlying bacterial infection or heart valve defects indicated the presence of a primary immunosuppressive viral infection.

To further investigate serologic evidence and necropsy findings, we looked for morbilliviral nucleic acid in nasal swabs archived from live otters and in tissue (brain, lung, lymph node) from 9 stranded carcasses from Kachemak Bay (southcentral stock, Figure 1, panel A) examined during 2005–2008. Total RNA was extracted by using Tri Reagent (Sigma, St. Louis, MO, USA) and complimentary DNA was transcribed by using Superscript III (Invitrogen, Carlsbad, CA, USA) with random nonamers. A heminested PCR was performed with universal morbillivirus primers and a PDV-specific primer for the phosphoprotein gene (*11*). Products of the expected size were sequenced.

Morbilliviral nucleic acid was amplified from 8 nasal swabs from live otters (10%, 8/77) and from lung, lymph node, or brain from 3 dead otters. Sequence analysis identified a PDV fragment identical to that of the isolate from the 2002 outbreak in northern Europe. This PDV fragment differed from the 1988 isolate at 2 nucleotide positions (Technical Appendix, available from www.cdc.gov/EID/content/15/6/pdfs/09-0056-Techapp.pdf; Figure 2). The PDV-positive nasal swabs were from 5 juveniles and 3 adults, 7 from the Kodiak Archipelago and 1 from the Eastern Aleutians. Seven of these 8 otters were also positive for antibodies to PDV by serum neutralization. The dead PDV-positive otters were 2 adults and 1 juvenile from Kachemak Bay sampled during 2005–2007. The cause of death in these animals included meningoencephalitis or sepsis with or without valvular endocarditis. This finding mirrors the secondary bacterial infections characteristic of infected and immunosuppressed European harbor seals during PDV epidemics (*1*).

Conclusions

These results demonstrate that PDV has been introduced to the North Pacific Ocean since 2000. All Pacific marine mammal species are now at risk for phocine distemper–induced population decreases. Although additional work is needed to determine if PDV has played a role in the decrease in the sea otter population, its association with lesions in carcasses, especially in animals that have died of bacterial infections, suggests it may contribute to ongoing deaths. Viral nucleic acid in nasal swabs from free-ranging, live-captured otters confirms viral shedding. Therefore, otters are capable of transmitting PDV to conspecifics and other species.

Because the PDV fragment isolated from Alaskan otters is identical to that of the 2002 Atlantic isolate, this virus was likely transmitted to the North Pacific Ocean after the 2002 European epidemic, although it is remotely possible that it may have originated in the North Pacific Ocean during 2000–2002. Several ranges of seal species overlap across the Atlantic and Arctic Oceans (Figure 1, panel B). Arctic and sub-Arctic migrating seals have also been suggested to be carriers of PDV (*1*). In the Atlantic Ocean, gray seals (*Halichoerus grypus*) are vectors of PDV that enable spread of disease to harbor seal populations and provide contact between North Sea and Arctic Ocean species (*12*) (Figure 1, panel B). Although PDV vector species are largely unknown, the close phylogenetic relationship and geographic range of susceptible seals with other seal species makes this intraspecies contact the likely method of transmission through the Arctic to the Pacific Ocean. Now that PDV is in the Pacific Ocean, the diversity and abundance of seal and sea lion species creates the potential for viral transmission (Figure 1).

Serologic evidence indicates that the 1988 Atlantic PDV virus did not reach the Arctic or Pacific regions of Alaska. The decrease in sea ice during the 14 years between these epidemics may have affected movement of Arctic seal populations (Technical Appendix Figure 2). This reduction was even more pronounced in 2004 and 2005, years in which PDV was confirmed to have infected sea otters (Technical Appendix). Ice coverage is at its lowest level during August and September (*14*). In 1988 and 2002, the PDV epidemic had reached gray and harbor seal populations in the North Sea and Norwegian Sea by August. This sea ice reduction may have altered seal haul-out and migration patterns, resulting in contact between Atlantic, Arctic, and Pacific Ocean species that was not possible in 1988 and the few years afterwards.

Now that PDV has been found in the Pacific Ocean, its role in population decreases and future mortality rates of currently uninfected species of marine mammals in Alaska must be assessed. A subspecies of the susceptible Atlantic harbor seal, the Pacific harbor seal is potentially vulnerable to PDV, and with a range from Alaska and along the West coast of the United States, they have enormous potential to spread the virus. Additionally, because terrestrial and marine Arctic species from Canada have previously been exposed to PDV, the risk for predatory and scavenging North Pacific Ocean carnivore species must not be overlooked (*15*). All seal species in the Arctic and Pacific Oceans are threatened, especially those with limited numbers, and epidemic management strategies must be in place to protect critically small populations.

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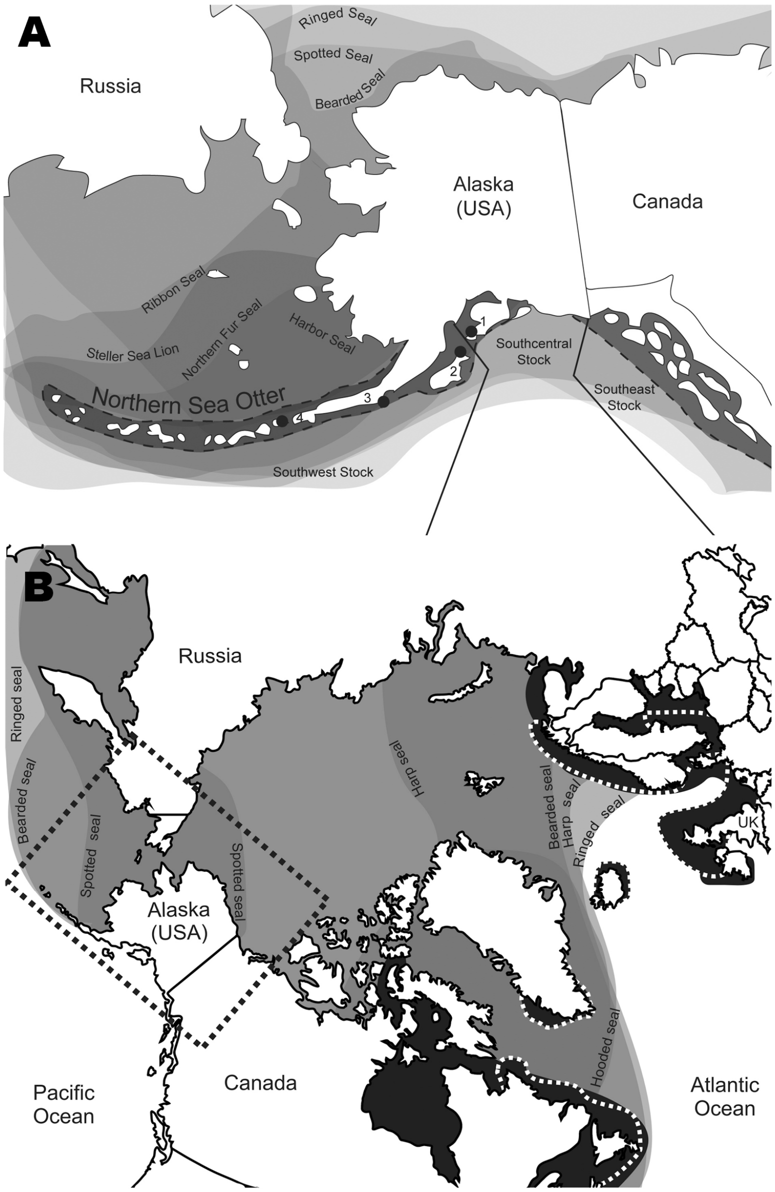

Figure 1. Distribution of Arctic and sub-Arctic pinnipeds in relation to Arctic ice coverage representing a unique area where distribution ranges of multiple seal species overlap (*7,8*). A) North Pacific Ocean region showing the range of the northern sea otter (*Enhydra lutris kenyoni*) in Alaska, its population stock delineations, and sample collection locations for the study. 1, Kachemak Bay; 2, Kodiak Archipelago; 3, South Alaska Peninsula; 4, Fox Island. These locations and seal species range overlap. This overlap indicates potential for phocine distemper virus disease transmission among Arctic and sub-Arctic pinniped species in this highly productive region. B) Circumpolar Arctic region showing species overlap among Arctic pinnipeds and the potential for disease transmission from the Atlantic Ocean through the Arctic Ocean to Alaska (outlined) by migrating seal species. The black areas indicate ranges of Atlantic harbor and gray seals; the areas exclusive to gray seal are bordered with a broken line. The boxed region corresponds to the Arctic region containing sea otter populations shown in panel A.

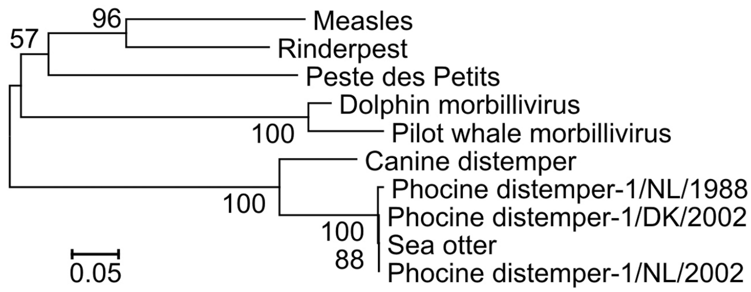

Figure 2. Neighbor-joining bootstrap tree (1,000 replicates, pairwise deletion comparisons, Tamura-Nei model) comparing all known corresponding phosphoprotein gene fragments from morbilliviruses (Technical Appendix, available from www.cdc.gov/EID/content/15/6/pdfs/09-0056-Techapp.pdf) by using Molecular Evolutionary Genetics Analysis software version 3.1 (www.megasoftware.net/mega.html) . Scale bar indicates number of nucleotide substitutions per site.

Appendix B

Steller Seal lion and Northern Fur Seal Research Final Programmatic Environmental Impact Statement NMFS 2009

Summary Document
Steller Sea Lion and Northern Fur Seal Research Final Programmatic Environmental Impact Statement
January 2009

Lead Agency:	United States Department of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Service Office of Protected Resources Silver Spring, Maryland
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ACRONYMS AND ABBREVIATIONS

ADF&G	Alaska Department of Fish and Game
AFDF	Alaska Fisheries Development Foundation
AI	Aleutian Islands
APPS	Authorizations and Permits for Protected Species
ASLC	Alaska Sea Life Center
AWA	Animal Welfare Act
C ALEU	Central Aleutians
CFEC	Alaska Community Fisheries Entry Commission
C GULF	Central Gulf of Alaska
DPS	Distinct Population Segment
E ALEU	Eastern Aleutians
E GULF	Eastern Gulf of Alaska
ESA	Endangered Species Act
FY	Fiscal year
GOA	Gulf of Alaska
IACUC	Institutional Animal Care and Use Committee
IISD	Internal Initial Scoping Document
IPCC	Intergovernmental Panel on Climate Chang
LXH	Life history transmitter
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NFS	Northern fur seal
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NPFMC	North Pacific Fisheries Management Council
NPUMMRC	North Pacific Universities Marine Mammal Research Consortium
OAR	Oceanic & Atmospheric Research
ODFG	Oregon Department of Fish and Game
PBR	Potential Biological Removal
PEIS	Programmatic Environmental Impact Statement
Policy Document	NMFS Policy and Guidance for Implementation of the Steller Sea Lion and Northern Fur Seal Research Permits and Grants Programs under the Preferred Alternative of the 2007 Final Programmatic EIS
PR1	Office Protected Resources
ROD	Record of Decision
PWSSC	Prince William Sound Science Center
SAM	Sub-adult male
SSL	Steller sea lion
SSLRI	Steller Sea Lion Research Initiative
UAF	University of Alaska Fairbanks
U.S.	United States
U.S.C.	United States Code
W	West
W ALEU	Western Aleutians
W GULF	Western Gulf of Alaska

Introduction and Summary

The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) is responsible for management, conservation, and protection of Steller sea lions (SSLs), *Eumetopias jubatus*, under the Endangered Species Act (ESA) (16 United States Code [U.S.C.] 1531 et seq.) and the Marine Mammal Protection Act (MMPA) (16 U.S.C. 1361 et seq.) and of Northern fur seals (NFSs), *Callorhinus ursinus*, under the MMPA. NFSs in the Pribilof Islands are also managed under the Fur Seal Act of 1966 (16 U.S.C. 1151 et seq.).

In 1990, NMFS listed SSLs as "threatened" under the ESA, and in 1997 it recognized two distinct populations: western and eastern. The segment of the population west of 144° West (W) longitude was listed as "endangered," while the segment of the population east of this delineation remained listed as "threatened." Both distinct populations of SSLs are listed as depleted stocks under the MMPA. NFSs, recognized as two distinct stocks (eastern Pacific and San Miguel), have never been listed under the ESA, but the eastern Pacific stock was listed as "depleted" in 1988 (then as the Pribilof Islands population) under the MMPA.

This document provides an overview of the findings contained in the SSL and NFS Research Programmatic Environmental Impact Statement (PEIS) published in June 2007 and summarizes new information that has become available since the PEIS was published pertinent to the analyses and conclusions made in Chapter 4 of the PEIS. The PEIS evaluated the effects of the type and range of SSL and NFS research activities (i.e., the alternative actions) that may be exercised using current and future grants and permits. The PEIS also assessed the direct and indirect effects of various levels of funding and different research techniques on SSLs and NFSs throughout the entire range of these species in United States (U.S.) waters and on the high seas, which includes parts of Alaska, Washington, Oregon, and California.

A Record of Decision (ROD) was signed on June 18, 2007. The ROD documented the Agency's decision to select the Preferred Alternative (Alternative 4: Research Program with Full Implementation of Conservation Goals) as its preferred strategy for the issuance of grants and permits for scientific research on SSLs and NFSs. NMFS determined that the implementation of the Preferred Alternative would be limited in duration and scope by restricting research permits to three field seasons (June 2007 through August 2009) while engaging in a program review. Upon completion of this program review, NMFS would adopt policy and guidance to improve implementation of the SSL and NFS research program (Chapter 5 of the PEIS).

NMFS conducted its program review in 2007 and 2008. A major element of the program review included convening a panel of independent experts in 2008; panel members provided expertise in endangered species recovery planning, marine mammal research, population modeling, and veterinary medicine. The panel conducted a review of the current SSL and NFS scientific research permit program and made recommendations on how to make improvements to the permitting process for these species, including coordination and monitoring of research. The panel provided a final report to NMFS in October 2008, which included a list of recommendations for improving the scientific research permit process. The final report is available on the NMFS website: http://www.nmfs.noaa.gov/pr/permits/eis/steller.htm

As part of this program review, NMFS released a policy and guidance document (Policy Document) for implementation of the research permit program for public review in December 2008. NMFS has determined that there were no substantive changes to the purpose and need, alternatives, affected environment, or evaluation of the alternatives since the release of the 2007 PEIS; therefore, a Supplemental PEIS is not required.

This document summarizes new information that has become available since the PEIS was published in June 2007. The interested reader is referred to the PEIS for the original analysis of environmental consequences. The numbering scheme used throughout this document follows the 2007 PEIS to allow cross-referencing. Chapter 5 of this summary also references the Policy Document. Public comments on the Policy Document received by the January 20, 2009 deadline will be reviewed by NMFS and revisions will be made to the Policy Document as appropriate. The revised document will be used to craft a new ROD for authorizing research activities associated with SSLs and NFSs.

1.0 PURPOSE AND NEED

This section summarizes the purpose and need from the 2007 PEIS. No changes are warranted because the purpose and need remains the same. The interested reader is referred to Chapter 1 of the PEIS more details on the purpose and need.

The purpose of conducting research on SSLs and NFSs, as stated in the SSL Recovery Plan (NMFS 2008) and NFS Conservation Plan (NMFS 2007), is to promote the recovery of the species' populations to levels appropriate to justify removal from ESA listings (in the case of SSLs) and to delineate reasonable actions to protect the depleted species (in the case of NFSs) under the MMPA. NMFS is the federal agency responsible for management, conservation, and protection of these species. NMFS facilitates research on SSLs and NFSs by awarding grants and issuing permits. This research may yield information that can be used by NMFS to develop more informed and effective management actions to promote recovery and conservation of SSLs and NFSs.

The need for NMFS' grant program for research on SSLs and NFSs is related to its obligations to administer directed grants from its operational budget and "pass through" grants detailed in the federal budget. These grants are administered through the NMFS Alaska Regional Office. The need for issuance of permits relates to the "take" prohibitions of the MMPA and ESA. The ESA and the MMPA prohibit ''takes'' of threatened and endangered species, and of marine mammals, respectively, with a few exceptions. Permits for bona fide scientific research are one such exception. A scientific research permit allows an exemption to the "take" prohibition for research activities that may result in harassment, harm, pursuit, capture, and mortality of SSLs and NFSs. Many scientific research activities require approaching or capturing animals and may result in harassment or other prohibited "takes." As such, most research activities on these species require permits, which NMFS issues to qualified individuals and institutions through the Permits, Conservation and Education Division (PR1), Office of Protected Resources, NMFS.

The legal and regulatory framework for NMFS' responsibilities regarding marine mammals were described in Section 1.7 of the PEIS. All of the alternatives carried forward for analysis in the PEIS must meet research and management needs within the scope of NMFS' legal limits and responsibilities. The MMPA and ESA give NMFS authority to place such terms and conditions in research permits as deemed appropriate. These conditions typically include specific mitigation measures that are required to minimize risk of adverse effects.

2.0 ALTERNATIVES

Four alternatives were carried forward for analysis in the PEIS. The alternatives represented a reasonable range of research granting and permitting options that fulfilled the purpose and need for the federal action (Chapter 1). These four alternatives are identified below. Table 2-1 summarizes examples of specific research activities permitted under each alternative.

- Alternative 1 – No Action: No New Permits or Authorizations
- Alternative 2 – Research Program without Capture or Handling
- Alternative 3 – Status Quo Research Program
- Alternative 4 – Research Program with Full Implementation of Conservation Goals

As documented in the 2007 ROD, NMFS selected the Preferred Alternative (Alternative 4) as the approach to issuing grants and permits for scientific research on SSLs and NFSs. This alternative allows the agency to fully implement the recommendations in the species' conservation and recovery plans. Implementation of the policy and guidance outlined in the Policy Document would be consistent with the Preferred Alternative (Alternative 4), and as such, no changes to the alternatives have been identified.

Table 2-1
Research Activities Allowed Under Each Alternative

Research Activities	Alternative 1 No Action: No New Permits or Authorizations	Alternative 2 Research Program Without Capture or Handling	Alternative 3 – Status Quo Research Program	Alternative 4 Research Program with Full Implementation of Conservation Goals
Research activities on live animals with NO capture, restraint, or collection of tissues				
Aerial surveys	*	√	√	√
Vessel surveys	*	√	√	√
Ground surveys	*	√	√	√
Scat collection	*	√	√	√
Remote video/photographic monitoring	*	√	√	√
Receipt of tissue samples from Alaska Natives that have taken the animal legally for subsistence harvest	√	√	√	√
Receipt of tissue samples from animals found dead from other causes	√	√	√	√
Research activities on live animals that requires capture, restraint, or collection of tissues				
Collection of morphometric measurements	--	--	√	√
Collection of blood samples	--	--	√	√
Muscle biopsies	--	--	√	√
Skin biopsies	--	--	√	√
Blubber samples	--	--	√	√
Fecal and fluid samples	--	--	√	√
Extraction of pre-molar teeth	--	--	√	√
Collection of vibrissae, hair, and nails	--	--	√	√
Enema or stomach intubation	--	--	√	√
Bioelectric Impedance Analysis	--	--	√	√
Ultrasound	--	--	√	√
Stable isotope injection	--	--	√	√
Chromic oxide and Co-EDTA	--	--	√	√
Temporary marking	--	--	√	√

Table 2-1 (Continued)
Research Activities Allowed Under Each Alternative

Research Activities	Alternative 1 No Action: No New Permits or Authorizations	Alternative 2 Research Program Without Capture or Handling	Alternative 3 – Status Quo Research Program	Alternative 4 Research Program with Full Implementation of Conservation Goals
Research activities on live animals that requires capture, restraint or collection of tissues				
Attachment (external) of scientific instruments measurements	--	--	√	√
Attachment (external) of scientific instruments measurements	--	--	√	√
Insertion/implantation (internal) of instruments	--	--	√	√
Temporary captivity	--	--	√	√
Intentional take of animals	--	--	--	√

Key: * No new permits or authorizations would be issued under Alternative 1. However, grants could be issued and surveys, observations, and scat collections could occur under circumstances that would not result in disturbance or takes.

-- Not Allowed
√ Allowed

3.0 AFFECTED ENVIRONMENT

3.1 INTRODUCTION

Chapter 3 of the 2007 PEIS described the biological, physical, and socioeconomic resources that may be affected by research on SSLs and NFSs or that may be involved in their respective population declines. The chapter included a summary of the biological environment of SSLs and NFSs and other species in Section 3.2; the physical environment in which these species occur in Section 3.3; the social and economic environment, including a context of subsistence harvesting and commercial fisheries in Section 3.4; communities associated with or near SSL and NFS research activities in Section 3.5; the economic impacts of federally funded research in Section 3.6; and the process for grants and permitting associated with SSLs and NFSs in Section 3.7.

The objective of the PEIS Chapter 3 was to describe the past and present characteristics of relevant species and resources, thereby defining their baseline conditions, as a basis for the analysis of direct and indirect effects of the alternatives and the cumulative effects analysis presented in Chapter 4 of the PEIS. This chapter documents whether or not the baseline condition for any of the relevant species or resources has changed substantially since the PEIS was published and therefore, whether further analysis of the environmental consequences (Chapter 4 of the PEIS) is necessary.

After careful review, the majority of information contained in Chapter 3 of the PEIS remains up-to-date since its publication in June 2007. The following sections present information that has become available since the PEIS was published and may be relevant to NMFS for permitting research on SSLs and NFSs. The numbering scheme used below follows the original document to allow cross-referencing. If no changes were identified, that subsection is not included in this review. The original PEIS Chapter 3 can be downloaded from the NMFS website at: http://www.nmfs.noaa.gov/pr/permits/eis/steller.htm.

3.2 BIOLOGICAL ENVIRONMENT

Section 3.2 of the PEIS described the biological environment of SSLs and NFSs. The section included summaries of the biology of these species including their distribution, population status, population trends, life history, and anthropogenic sources of mortality and disturbance. Also included were summaries of traditional knowledge, past research and funding programs, coordination of research, Recovery and Conservation Plans, and co-management agreements for SSLs and NFSs.

3.2.1 Steller Sea Lion

The first SSL subsections (3.2.1.1 – 3.2.1.16) of the PEIS Chapter 3 described biological information for SSLs. Updates to population status and trends (Section 3.2.1.2), current research (3.2.1.11), coordination of research (3.2.1.12), and SSL Recovery Plan (3.2.1.15) have been updated in the following text. The remaining sections are still relevant, but no changes are warranted.

3.2.1.2 *Population Status and Trends for SSL*

This section of the PEIS described the critical habitat, population status, and population trends of the western and eastern Distinct Population Segments (western DPS and eastern DPS, respectively) of SSLs. Since the publication of the PEIS, NMFS published results of aerial surveys undertaken during 2007 and 2008 to assess trends of adult and juvenile (non-pup) SSLs at trend sites in Alaska (Fritz et al. 2007, 2008). Trend sites are those that have been consistently surveyed since the mid-1970s and 1990s. The 2007 survey was incomplete, covering 65 of the 87 trend sites from the 1970s and 124 of the 161 trend sites within the range of the western DPS from the 1990s. The 2008 survey was the first complete survey of trend sites within the range of the western DPS since 2004 and the first complete survey of trend sites within the Alaska portion of the eastern DPS range since 2002. Counts of the western DPS in Alaska have generally been combined and analyzed in six sub-areas: Western Aleutian Islands (W ALEU), Central Aleutian Islands (C ALEU), Eastern Aleutian Islands (E ALEU), Western Gulf of Alaska (W GULF), Central Gulf of Alaska (C GULF), and Eastern Gulf of Alaska (E GULF).

Between 2004 and 2008, counts of non-pups on all 1990s trend sites within the range of the western DPS in Alaska increased by 748, or 3 percent (Fritz et al. 2008). However, there was considerable variation in counts between 2004 and 2008 by sub-area (Table 3-1):

- In the E GULF, counts increased by 1,090, or 35 percent
- In the C GULF, W GULF and E ALEU, counts increased between 337 and 430, or between 6 and 10 percent
- In the C ALEU and W ALEU, counts declined by 1,108 and 407, or declining by 16 and 30 percent, respectively

There is evidence to suggest that at least some of the observed increase in the E GULF could be due to animals from the eastern DPS foraging in the Gulf of Alaska in early summer and resting on haulouts within the range of the western DPS. These animals would be expected to move back to their natal colonies in Southeast Alaska in July. Excluding the E GULF trend sites, the trend counts within the range of the western DPS declined about 1 percent from 2004 to 2008 (Table 3-1).

The most recent aerial surveys (2004-2008) indicate that the overall population of the western DPS is stable or declining slightly. This followed a period (2000-2004) where the overall trend was increasing at approximately 3 percent per year, although there were marked differences in trends between sub-areas. This general pattern was acknowledged in the PEIS and was thus incorporated into the baseline for SSLs.

Table 3-1
Counts Of Adult And Juvenile (Non-Pup) SSLs at 1990s Trend Sites
Within the Range Of the Western DPS*

Region	2004	2006	2007	2008	Count Change (2008-2004)	Percent Change (2008-2004)
E GULF	3,129	3,218	2,865	4,219	1,090	35 percent
C GULF	4,180			4,587	407	10 percent
W GULF	5,431			5,768	337	6 percent
E ALEU	6,217	6,259		6,647	430	7 percent
C ALEU	7,145			6,037	- 1,108	- 16 percent
W ALEU	1,335			928	- 407	- 30 percent
Total	27,437			28,185	748	3 percent
C GULF-W ALEU	24,308			23,966	- 342	- 1 percent

*Data are unadjusted counts from vertical high resolution aerial photographs taken in June 2004-2008. Only data from completely surveyed regions are presented. (From Fritz et al. 2008, Table 5)

3.2.1.11 *Recent Studies on SSLs*

Researchers are required to list the publications and presentations that have resulted from their authorized research in their annual permit reports. A list of citations from the 2007 and 2008 annual reports for research permits is provided in Appendix A. Many publications and presentations have used data collected under earlier permits. Many publications and presentations are collaborative efforts by authors from different agencies and research groups. Publications that concern the effects of research on SSLs have either been incorporated into the PEIS or are summarized in Chapter 4 of this document.

3.2.1.12*Coordination of Research for SSLs*

Section 3.2.1.12 of the PEIS describes the mechanisms implemented by NMFS to coordinate SSL research in response to the dramatic increase in research funding and scientific research on this species. These mechanisms include the development of a research coordination framework to clarify the context of individual research projects, to show their relationships to each other, and to link them to the underlying hypotheses that might explain the continued decline of SSLs. Additionally, NMFS and SSL researchers have conducted meetings, workshops, and symposia since 2000 that focus on research coordination, collaboration, and communication. These meetings aim to minimize and mitigate potential research-related impacts, considering the increased interest and funding of SSL research.

Since the publication of the PEIS, there have been two SSL research coordination meetings held in association with Alaska Marine Science Symposia. These meetings were held in Anchorage on January 24, 2008 and January 23, 2009. A summary of these meetings is provided below.

Participants at the 2008 SSL meeting included researchers and managers from NMFS and Alaska Department of Fish and Game (ADF&G), as well as representatives from research organizations holding SSL permits. Prior to the coordination meeting, all investigators permitted to conduct SSL research in Alaska were requested to complete a spreadsheet listing locations, dates, and activities for their planned 2008 Alaska field studies. Similar to the 2007 research coordination meeting, this information was used to develop a coordination matrix to aid in coordination and timing and location of research activities. The matrix was used to identify potential areas of overlap/overuse to alert researchers where further coordination is warranted. New in 2008 was a request to associate each activity with an SSL Recovery Plan recovery priority (Fadely 2008).

Field research activities addressed a broad range of SSL Recovery Plan research priorities, and most field projects address multiple priorities. Field activities were scheduled to be conducted throughout the entire year and across most of the SSL range in Alaska. Using the number of site visits within the coordination matrix as an index of activity, most effort is associated with aerial surveys and skiff-based observations during scat collections, and most site visits are to locations in the W GULF, C GULF, C ALEU, E ALEU, and E GULF. Potential overlaps in timing and location of field studies among research groups were identified, discussed, and resolved at this meeting.

Other issues discussed at the meeting were: the impacts of budget cuts or lack of funding on field and laboratory studies; the nature and timing of actions to be taken by PR1 involving research reviews, and the development of an SSL research plan. The complete report from the 2008 research coordination meeting, including the completed decision matrix, is located on the NMFS website at http://alaskafisheries.noaa.gov/protectedresources/stellers/recovery.htm.

The complete report from the 2009 SSL Research Coordination Meeting is not yet available from NMFS however some key issues addressed at the meeting included:

- An overview of proposed SSL research for 2009;
- Research on SSLs in Russia;
- Need for research on adult female fecundity;
- Fisheries closures and adaptive management policies;
- The development of a matrix identifying how permitted research activities relate to SSL Recovery Plan recovery priorities;
- An overview of the independent panel review of the current SSL and NFS scientific research permit program;
- Institutional Animal Care and Use Committee (IACUC) review of research;
- PBR as basis for research takes;
- A potential reduction in the number of SSL takes authorized based on population declines;
- The coordination of SSL takes between permit holders in an effort to manage the utilization of takes; and
- Collaboration between principal investigators of scientific samples (collected blood, feces, etc.) to reduce the number of takes.

3.2.1.14 *Recovery Plan*

The revised Final SSL Recovery Plan was signed in March of 2008 (NMFS 2008). There are no updates relating to scientific research in the Final plan.

3.2.2 Northern Fur Seal

The first NFS subsections (3.2.2.1 – 3.2.2.16) of the PEIS Chapter 3 described the biological information for NFSs. Updates to population status and trends (Section 3.2.2.2), current research (3.2.2.10), and NFS Conservation Plan (3.2.2.13) have been updated in the following text. The remaining sections of the PEIS are all relevant, but no changes are warranted.

3.2.2.2 *Population Status and Trends for NFSs*

This section of the PEIS described the critical habitat, population status, and population trends of eastern Pacific stock and San Miguel Island stock of NFSs. At the time of release of the PEIS in 2007, the most current population estimate for the eastern Pacific stock of NFSs was 721,935 seals and the Potential Biological Removal (PBR) was 15,272 seals. Since the publication of the PEIS, NMFS published a memorandum stating the results of adult male and pup counts in 2008 to assess trends of NFSs at the Pribilof Islands and Bogoslof Island (Towell and Ream 2008).

In 2008, adult males on the Pribilof Islands were counted in July and pups were counted using shear-sampling, a mark-recapture technique, in August. While a 4.6 percent increase in adult male fur seals was noted in the 2008 counts, pups counts are lower than they have been in 92 years. These counts estimated a population of 102,674 pups on St. Paul Island and 18,160 on St. George, or about 121,000 pups on the combined Pribilof Islands. In the same area, pup counts in 1992 showed an estimated 253,000 pups. Pup mortality rates were also estimated during this time at 5.3 percent at St. Paul and 5.4 percent at St. George, an increase from 2004 and 2006 estimates (Towell and Ream 2008).

An overall population increase of NFSs was noted in 2008 counts on St. George Island as well as Bogoslof Island. However, the total Pribilof Islands population has shown a 5.2 percent annual decline since 1998 and a 4.9 percent decline in pups since 2006. The total population for the eastern Pacific stock of NFSs was estimated to be 666,000 (Towell and Ream 2008).

3.2.2.10 *Recent Studies on NFSs*

Researchers are required to list the publications and presentations that have resulted from their authorized research in their annual permit reports. Citations from the 2007 annual reports are listed in Appendix A. Many publications and presentations have used data collected under earlier permits and are collaborative efforts by authors from different agencies and research groups. There have been no publications that concern the effects of research on NFSs, although the annual permit reports discuss this topic to various extents and that information has either been incorporated into the PEIS or are summarized in Chapter 4 of this document.

3.2.2.13 NFS Conservation Plan

As required by the MMPA for depleted stocks, NMFS developed and published a Conservation Plan for NFS in 1993 (NMFS 1993). The 2006 NFS Draft Conservation Plan (NMFS 2006b) was later published as a revision to the 1993 Conservation Plan that took into account the reclassification of the eastern Pacific stock of NFSs to include the Pribilof Islands and Bogoslof Island, but not San Miguel Island, along other updates in management structure, new data, and identification of research priorities. After the PEIS was published in May of 2007, NMFS released the 2007 Final Conservation Plan (NMFS 2007) for the eastern Pacific stock of NFSs.

3.2.3 Other Species

Sections 3.2.3 – 3.2.7 of the PEIS described the terrestrial and marine species mammals that could occur in the project area addressed in the PEIS. These sections included descriptions of killer whales (3.2.3), other ESA-listed species (3.2.4), other marine mammals (3.2.5), fish (3.2.6), other marine species (3.2.7), and ecosystem interactions (3.2.8). Some species, such as killer whales, have been subject to a substantial amount of research since 2007 but the PEIS found no substantial effects of SSL and NFS research on any of these other species. NMFS does not foresee any significant changes in the nature of effects of SSL or NFS research on these other species. updates to the baseline information on other species are not warranted. Since 2007 NMFS has listed or proposed to list five marine mammals: Cook Inlet beluga whales, ribbon seals, ringed seals, bearded seals, and spotted seals.

Cook Inlet Beluga whale

On October 22, 2008 NMFS listed the Cook Inlet stock as endangered under the ESA. Beluga whales (*Delphinapterus leucas)* inhabit the Arctic Ocean and its adjoining seas, including the Sea of Okhotsk, the Bering Sea, the Gulf of Alaska, the Beaufort Sea, Baffin Bay, Hudson Bay, and the Gulf of St. Lawrence. Of the five stocks, the Cook Inlet stock is the most isolated; genetic samples suggest these whales have been isolated for several thousand years. The Cook Inlet stock has been severely reduced in numbers over the last several decades. NMFS estimates this population numbered as many as 1,300 in the late 1970s. By 1994, the estimate was only about 650. The current estimate is about 280 whales.

Ribbon, ringed, bearded, and spotted seals

After receiving a petition to list the ribbon seal (*Histriophoca fasciata*) as endangered under the ESA, NMFS initiated a status review of the ringed (*Phoca hispida*), bearded (*Erignathus barbatus*), and spotted seal (*Phoca largha*) as well. NMFS is actively considering listed these species as endangered while the ribbon seal is considered a species of concern. These seals inhabit the Arctic Ocean and North Pacific Ocean and are commonly found in drifting sea ice, ice floes, and pack ice. Climate change is potentially the most serious threat to these seal populations since much of their habitat is dependent upon pack ice.

3.3 PHYSICAL ENVIRONMENT

Section 3.3 of the PEIS described the physical environment that encompasses the entire range of SSLs and NFSs in California, Washington, Oregon, and Alaska including the eastern and western populations of SSLs. Included in Section 3.3 was a description of the following: ecosystems of the North Pacific Ocean off the U.S. west coast, Bering Sea and Gulf of Alaska (3.3.1); substrate within these regions (3.3.2); water column including temperature and nutrient regimes (3.3.4); climatic regime shifts (3.3.5); distant forcing parameters (3.3.6); and coastal land characteristics including sanctuaries, parks and historic sites, and designated critical habitat areas, rookeries and haulouts (3.3.7). Updates to climatic regime shifts have been updated in the following text. The remaining sections of the PEIS are all relevant, but no changes are warranted.

3.3.5 Climatic Regime Shift

Subsection 3.3.5 of the PEIS presents the results of various studies that provide evidence on climatic changes in the North Pacific Ocean and the factors that affect or influence this change. It also includes a discussion of how these shifts affect fish stocks.

Since the publication of the PEIS there has been a great deal of literature published about the observed changes in climate change and their effect on natural systems. The 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) published in November 2007 (IPCC 2007; http://www.ipcc.ch/ipccreports/ar4-syr.htm) observed that eleven of the twelve years between 1995 and 2006 ranked among the twelve warmest years in the instrumental record of global surface temperature. The IPPC report provides evidence of effects consistent with global warming including:

- rising sea levels;
- observed changes in snow and sea ice extent;
- significant increases in precipitation in certain regions and an increase in drought affected areas;
- a likely reduction in the frequency of cold nights and frosts over most land areas and a likely increase in the frequency of hot days and nights;
- observational evidence of an increase in intense tropical cyclone activity in the North Atlantic since around 1970; and
- a likely increase in the average Northern Hemisphere temperatures during the second half of the 20th century.

While the report does not detail the impact of climate change specifically on the North Pacific Ocean it does present information regarding the impact of these effects of climate change on the natural environment. The report states that in some marine and freshwater systems, shifts in ranges and changes in algal, plankton and fish abundance are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation (IPPC 2007).

3.4 SOCIAL AND ECONOMIC ENVIRONMENT

Section 3.4 of the PEIS described the social and economic environment within the geographic range of SSLs and NFSs. This included a summary of the contemporary context of the subsistence harvest of SSLs and NFSs in Alaska (3.4.1) and a summary of the economic information related to the commercial fisheries in Alaska, on the U.S. west coast, and the Canadian west coast (3.4.2-3.4.3). No changes are warranted in this section.

3.5 COASTAL COMMUNITIES

Section 3.5 of the PEIS describes the interactions between SSL and NFS researchers and the types of impacts that may accrue to coastal communities as part of the research process. These include (1) direct interactions with communities in the course of permitted research-related activities (3.5.1), (2) interactions with community-based commercial fishing activities (3.5.2), (3) interactions with community-based SSL and NFS subsistence activities (3.5.3), and (4) environmental justice impacts (3.5.4). (Communities may also experience interactive impacts based on several different types of impacts occurring simultaneously.) Updates to the interactions with community-based commercial fishing activities (3.5.2) section are provided in the text below. The remaining sections are all relevant, but no changes are warranted.

3.5.2 Interactions with Community-Based Commercial Fishing Activities

The PEIS described that SSL and NFS research may be directly or indirectly related to commercial fishing activities, but the nature of these interactions has not been established. More recent data (2003-2007) has become available since the publication of the PEISIt is likely that the overall distribution of revenue by gear type is similar to the trend displayed in the PEIS, as the general trend by species displayed in the PEIS is similar to the more recent data.

3.6 ECONOMIC IMPACTS OF FEDERALLY FUNDED RESEARCH

This section updates information in the PEIS on the economic impacts of federally funded SSL and NFS research. First, information for fiscal year (FY) 2008 on the levels and recipients of SSL and NFS research funding is provided. Next, the funding level for FY 2008 is used to estimate the regional economic impacts of SSL and NFS research expenditures.

The PEIS pointed out that the regional economic impacts of SSL and NFS research expenditures do not necessarily account for all the economic impacts of SSL and NFS research. The output of SSL and NFS research activities can also produce benefits and costs for society that may not be readily translated into dollar values. As discussed in the PEIS, SSL and NFS research activities improve the welfare of a segment of the American public if those activities contribute to the protection and enhancement of SSL and NFS populations. Alternatively, SSL and NFS research activities may have a negative effect on the welfare of some people if those activities harm SSL and NFS populations or individual members of the two species. Since implementation of the PEIS ROD, no new information has become available regarding the level of these potential benefits and costs associated with SSL and NFS research.

3.6.1 Overview of Levels and Recipients of SSL and NFS Research Funds

Table 3.13 provides a revised and updated overview of federal funding levels for SSL research and management by FY.

As shown in Table 3.13, funding for SSL research peaked in 2001 and 2002. Funding levels since that time have fluctuated, but there has been an overall downward trend. By 2008, funding for SSL research and management was approximately one-fifth of the 2001 level.

SSL research funding is not expected to reach the 2001/2002 levels again in the foreseeable future. The budget for SSL research since 2001 has been the largest for a U.S. endangered species (Holmes et al. 2006). It has been argued that this investment in SSL research and management is prudent given the economic importance of the commercial fisheries potentially at stake (e.g., Hogarth 2005); however, some researchers have expressed concern about the high level of federal funding for research on a single species at a time when research funds for many other endangered species are non-existent (Dalton 2005).

Table 3.13
Funding for SSL Research and Management, FY 2000-2008

	FY00	FY01	FY02	FY03	FY04	FY05[1]	FY06[2]	FY07	FY08	Total[3]
	(Thousands of Dollars)									
NMFS	1,100	7,850	17,650	5,850	4,611	9,350	4,558	2,828	2,749	56,546
ADF&G	990	2,500	2,495	2,000	2,000	3,200	2,466	1,606	1,100	18,357
NPUMMRC	720	800	3,500	2,500	2,500	2,500	1,972	1,678	486	16,656
ASLC	900	6,000	5,000	5,000	6,000	7,000	5,128	4,200	3,500	42,728
UAF		1,000	1,000	1,000	1,000	1,500	986	296	487	7,269
NPFMC		2,000	2,000	2,000	2,000	2,000	1,479			11,479
OAR		6,000	6,000							12,000
NOS		2,000	2,000							4,000
SSLRI		15,000								15,000
AFDF			500	1,000	1,000					2,500
PWSSC					1,000	1,000				2,000
Total	3,710	43,150	40,145	19,350	20,111	26,550	16,589	10,608	8,322	188,535

NMFS- National Marine Fisheries Service
ADF&G- Alaska Department of Fish & Game
NPUMMRC- North Pacific Universities Marine Mammal Research Consortium
ASLC- Alaska SeaLife Center
UAF- University of Alaska Fairbanks
PWSSC- Prince William Sound Science Center
NPFMC- North Pacific Fishery Management Council
OAR- Oceanic & Atmospheric Research
NOS- National Ocean Service
SSLRI- Steller Sea Lion Research Initiative (non-Federal competitive grant program)
AFDF- Alaska Fisheries Development Foundation

Note:
[1]FY05 Congress provided flexibility to use funding to support research on any Alaska pinniped population
[2]FY06 Congress consolidated 44 budget lines into a single PPA titled Alaska Composite Research & Development
[3]Discrepancy in totals resulting from difference in gross appropriations & assessments/rescissions

Source: NMFS Alaska Regional Office 2008

Funding dedicated for NFS research continues to be a small fraction of the funding for SSL research. Since 2004, the North Pacific Research Board has awarded $1.91 million for studies investigating the causes of NFS population declines in the Pribilof Islands. Recipients of these funds include the University of Alaska Fairbanks (UAF), NMFS Alaska Fisheries Science Center (AFSC), Alaska Sea Life Center (ASLC), University of Washington, and North Pacific Universities Marine Mammal Research Consortium (NPUMMC). There was relatively little field work conducted on NFSs in 2007, in part because of funding issues that prevented continuation of planned projects.

3.7 GRANT AND PERMITTING PROCESS

This section of the PEIS described the statutory and regulatory basis for the permitting and funding of research on SSL and NFS. No changes are warranted in this section.

4.0 ENVIRONMENTAL CONSEQUENCES

This section summarizes new information that has become available since the PEIS was published in June 2007 and that is pertinent to the analyses and conclusions made in Chapter 4 of the PEIS. The interested reader is referred to the PEIS for the original analysis of environmental consequences. The numbering scheme used below follows the original document to allow cross-referencing.

The beginning sections of the PEIS Chapter 4 (4.1 through 4.7) described the foundation and format of the effects analysis. These sections all remain relevant but no changes are warranted because there are no new alternatives or new research methodologies to analyze.

4.8 BIOLOGICAL ENVIRONMENT

4.8.1 Steller Sea Lion

The PEIS analyses of the effects of the four different research alternatives on SSLs. The analysis of the direct and indirect effects of research activities is divided into three major components: an assessment of research-related injuries that lead to serious injury or mortality; an assessment of research-related effects on reproductive success; and an assessment of how well each alternative research strategy would address recovery and conservation objectives for the species.

4.8.1.1 *Mortality Assessment Tables*

The assessment of research-related injury and mortality, using a formal mortality assessment process tied to known or suspected mechanisms of injury, is the first part of the analysis presented in the PEIS. The PEIS describes the development of a series of mortality assessment tables, including the basis and sources of information for the specific rates of behavioral responses, injury, and mortality used in the tables. In many cases, data for specific rates were not available and were estimated based on the professional judgment of highly experienced scientists at NMML. In other cases, data from research trip reports and, in a few cases, studies designed to examine research effects on SSLs were used in the assessment tables. Since the publication of the PEIS, several papers have been published that are pertinent to the risk assessment model. In addition, most current permit holders have filed annual reports for work conducted in 2007 and 2008, some of which discuss relevant behavioral responses and injury rates. These new sources of information are summarized here with comments about how they relate to the analysis.

Researcher Presence in View of Animals

<u>Aerial Surveys</u>

The PEIS noted that SSLs generally show little reaction to aerial surveys, with the proportion of animals becoming "alert" or entering the water varying among sites depending on the morphology and acoustic properties of the site. Given this variability among sites, the PEIS set the disturbance rates for aerial surveys as follows:

> "Given the range of alert response rates with no age-class specificity (0.013 - <0.10), 0.05 was selected as an estimate of the proportion of animals effected for the "alert" response rate for both pups and non-pups. Because no pups were observed entering the water in response to aerial surveys, their 'enter water' rate was set to 0.0. For non-pups the 'enter water' rate was set to 0.01 (likely an overestimate based on field camp reports and the proportion of sites on flat offshore islands)".

The only research group to report animals' responses to aerial surveys in 2007 or 2008 was NMML (permit 782-1889). The Oregon Department of Fish and Game (ODFG) (permit 434-1892) reported no observed behavioral responses during their aerial surveys and concluded, "…aerial surveys did not have any discernable effect on animals." NMML's annual report for 2007 described different SSL responses at different sites, consistent with the description in the PEIS. At Ugamak Island, observers on land were not present when the aerial survey passed over the rookery but reported that within ½ hour of the overflight all non-pups were in the water and heading back to the beach. In contrast, observers at Marmot Island Beach 4 noted the survey aircraft made four passes over the beach, three offshore and one directly overhead of the animals. The observers noted that approximately 30-50 SSLs became alert during the direct overhead pass, none entered the water, and none were injured or died. Similarly, the observer at Marmot Island Beach 7 noted that no animals were disturbed during any of the four passes.

NMML's annual report for 2008 includes a photographic analysis of how many SSLs moved (an indicator of potential disturbance) after an aerial survey plane passed over the rookery or haulout. This analysis found that the number of animals actually disturbed is only about 2 to 3 percent of the number of animals present. Researchers estimate how many animals will be present during their aerial surveys and request that number of "takes" on their permits, even though the number of animals with observed behavioral responses is usually much less than the number of animals present.

<u>Vessel surveys</u>

The PEIS notes that, in contrast to aerial and on-land surveys, researchers request incidental disturbance takes for vessel surveys as the number of SSLs that are likely to be affected (which may be less than the number of animals present), and thus all of these animals are assumed to be alerted (a proportion of 1.0). The PEIS defines other reaction rates:

> "Proportions of SSLs entering the water during vessel surveys depend on age class and season. ADF&G estimated that the highest mean proportion of animals entering the water during their studies (primarily during breeding season) is 10-13 percent (0.10-0.13), but may be as low as 3 percent (0.03). NMML surveys for marked animals in the Gulf of Alaska (GOA) and Aleutian Islands (AI) during May of 2004-2006 found 30 percent (0.30) of non-pups entered the water. Thus, the 'enter water' rates for breeding season non-pups was estimated at 0.10, non-breeding season non-pups at 0.30, and breeding season pups at 0.0."

Several research groups conducted vessel surveys in 2007. The ODFG (permit 434-1892) reported, "Disturbance to pinnipeds during vessel surveys was limited to animals becoming alert to the presence of the vessel". The ADF&G (permit 358-1888) reported: "In general, when we approached hauled out animals in the skiff, most animals showed no reaction to our presence. A small number of animals at most sites became alert, possibly due to our presence, and a few animals went into the water. In total 64 percent of the animals that showed reaction to our presence looked up or moved around on the rocks without going to the water, and the remaining 36 percent entered the water at some time during our presence." This proportion of animals entering the water is thus slightly higher than the value used in the PEIS, although the total number of animals actually entering the water was still small. The ADF&G report continues: "At only one site (Yasha Island on 7/14/07) did a relatively large number of animals enter the water (approximately 120 entered the water at this site where an estimated >650 animals were hauled out [18percent]). The cause of this disturbance was likely due in part to very dense fog that made it difficult for the animals to see our skiff from a distance." No injuries, mortalities, or evidence of mother-pup pair bond disturbances were observed during vessel surveys. NMML also conducted vessel-based surveys for brand re-sights in 2007 and 2008 but they reported take data from those efforts in conjunction with take data from activities that involved researcher presence among animals (see section below).

The ODFG report for 2008 states that, "disturbance was primarily limited to animals becoming alert to the presence of the vessel; occasionally a small fraction of animals entered the water." The ADFG report for 2008 cites the same statistics as used in the 2007 report and adds, "We continue to be cautious as we approach sea lion haulouts and rookeries and have increased our vigilance in order to quickly identify sea lion reaction to our presence, allowing us to quickly back away and so reduce disturbances."

Researcher Presence Among Animals

Ground counts, scat collection, other activities on land

The PEIS assumed that all animals exposed to researchers moving amongst them would be at least alerted by the presence of researchers on a rookery or haulout. The PEIS estimated that only a small proportion of pups (0.01) enter the water while most of the non-pups enter the water (0.9). In the case of research involving captures of pups, non-pups are intentionally and slowly herded out of the way and usually enter the water.

NMML (permit 782-1889) reported on two separate research cruises in 2007. In the C ALEU and W ALEU, 302 non-pups and 717 pups were counted and disturbed during ground counts among three rookeries (Cape St. Stephen, Cape Sabak, and Billingshead). No stampedes of non-pups occurred, nor were any occurrences of pups being trampled or entering water observed. In the C GULF and E GULF, 69 visits were made to 54 sites throughout the study area, of which 31 sites were occupied by at least one sea lion. An estimated 7,558 non-pup sea lions were observed, of which an estimated 562 (7.4 percent of observed non-pups) were disturbed by re-sight, scat collection, or pup research activities. It is difficult to make a direct comparison of these numbers to those used in the PEIS because these data include a mix of observations where researchers only scanned some sites from off-shore vessels (see discussion of vessel surveys in the "researcher presence in view of animals" section above) and went ashore among animals at other sites.

The 2007 NMML report also contains the following:

> "An observer at Marmot Island Beach 4 recorded sea lion reactions to the arrival and presence of researchers capturing and handling 50 pups on July 1, 2007. The observer noted that no sea lions reacted to the arrival of the first skiff at the south end of the beach. Activity of researchers on the beach and subsequent arrival of two more skiff loads within the next 30 minutes caused sea lions at the southern end to become aware of researcher presence, vocalize and sit-up. Sub-adult males entered the water. Researchers then cleared an area of the southern end of the beach of non-pups and began pup-handling. Two pups were observed to enter the water but both returned to shore in the vicinity of the researchers. Sea lions at the northern end of the beach appeared relatively unaware of the researcher presence, and many continued sleeping. After about 1.5 hours on the beach, the researchers moved north to work a second group of pups. Sea lion male-to-male aggression increased, and adult females were observed in the water rafting just off the beach. By three hours on the beach a third group of pups were being captured and handled, and females at the north end of the beach were still calm and nursing pups. The north end of the beach was not disturbed by pup handling work."

Fritz et al. (2008) examined daily observational data from the Marmot Island rookery in the years 2000-2005. In three of these years (2000, 2002, and 2004) researchers came ashore at the rookery to capture and brand pups. The disturbance caused most adults and juveniles to enter the water but the pups stayed on shore and were herded together for handling. The branding effort each year took 6.5-10 hours (all in one day) and was monitored by observers on the surrounding cliffs, out of sight of the SSLs. The authors compared behavioral and attendance data within and between years with researcher presence on the rookery and those years when researchers did not disturb the rookery. They found that 3 out of 12 types of sex/age class/behaviors they examined changed significantly after the researchers left and the SSLs returned to the rookery; a decrease in the proportion of females resting, an increase in the proportion of females showing aggression to other SSLs, and an increase in the number of males that were active. These behavioral differences were significantly different from non-disturbed behaviors for 1-5 days after the researchers left. All other behavioral indices were indistinguishable from non-disturbed years and these three indices reverted to undisturbed levels after five days. Although there was no explicit time element built into the mortality assessment tables in the PEIS, these data informed the development of the mortality assessment tables in regards to short versus long-term disturbance on rookeries and was considered in the context of potential mechanisms of injury in the risk assessment.

The NMML report for 2008 includes an extension of the analysis presented in Fritz et al. (2008) to the observational data from 2007. In 2007, researchers came ashore and captured 50 pups by hand and did morphological measurements, blood draws, and took skin tissue samples but did not brand any pups. The 2008 report summarizes the results:

> "Similar to findings for the 2000-2005 data, model analyses indicated that in 2007 counts of all age/sex classes were higher following the research disturbance than were predicted had no research disturbance occurred. There was less change in sea lion behavior than in previous years. However, in branding years behavioral and attendance changes were small and temporary, and research disturbances of any kind were well-within the ranges observed in non-research disturbance years."

The ASLC report for 2007 (permit 881-1890) noted that, "researchers accessed Chiswell Island for routine remote-video camera maintenance and repair. No animals were handled but 160 SSL adults, juveniles, and pups were disturbed. About half of those entered the water and the other half showed increased levels of alertness." No injuries or mortalities were observed.

In 2008, ODFG (permit 434-1892) reported on their ground count efforts; "…disturbance was primarily limited to animals becoming alert to the presence of the researchers; a fraction of animals were disturbed enough to move away from the researchers and an even smaller fraction entered the water."

Researchers collecting fresh scat for diet analyses often disturb animals on rookeries or haulouts and cause them to enter the water. In an effort to reduce such disturbance on rookeries, where pups may be injured by trampling, Trites and Calkins (2008) examined whether the diets of bachelor bulls hauled out away from a rookery could be used as surrogates for the diets of breeding females on a rookery. They found the diets of breeding females from three nearby beaches did not vary significantly among themselves but did vary significantly from the diets of males hauled out nearby, both in species taken and the size of prey. They conclude that the diets of breeding females in a rookery complex may be ascertained by scat analysis in one discrete location rather than sampling many separate sites at a time (and disturbing more animals). Sampling effort could also be rotated to different sites in different years, thus reducing overall disturbance at any one site. However, the diets of nearby males could not be used to determine the diets of breeding females. Although this information would not affect the rates of disturbance used in the PEIS assessment tables, it could be used during the design of future studies to reduce the number of animals disturbed during the collection of dietary data and thus reduce the overall impact on the animals in a given area.

Capture and handling

Pups

In 2007, NMML (permit 782-1889) captured 536 pups by hand on 12 rookeries for measurements, sampling, and/or temporary marking (no branding or gas anesthesia). No efforts were made to capture non-pups. No adverse effects of handling, restraint, or sampling of pups were observed. No pups were observed or suspected to be abandoned as a result of the research activities. There were no observed mortalities or serious injuries.

For 2008, NMML reported that 478 SSL pups were captured by hand at eight rookeries between the E ALEU and C GULF for measurements, sampling, and/or marking. No efforts were made to capture non-pups. A total of 178 pups were hot-branded at Marmot (n = 85) and Sugarloaf (n = 93) Island rookeries, all of which received gas anesthesia. Blood samples were collected from 92 pups, and attempted on 10 pups for a total of 102 blood-sample takes. Skin biopsies for genetic analysis were collected from 396 pups. No adverse effects of handling, restraint, or sampling of pups were observed. No pups were observed or suspected to be abandoned as a result of the research activities. However, NMML reported on two pup mortalities that appear to have occurred on the same dates as their research-related presence on the rookeries. On one pup, the necropsy determined that the cause of death was “focal blunt trauma” or skull fracture, likely from hitting its head on a sharp rock or being hit by a falling rock. NMML concluded, “It is impossible to know whether this pup died as a result of researcher disturbance or of natural causes, but as the proximate mechanism of death seems to be independent of researcher activities we have not claimed this mortality on our permit.” The other pup was found dead on top of a large rock just after the adults had moved off. The pup had vomited milk but there were no other external signs of trauma. The necropsy determined that the cause of death was milk aspiration. NMML concluded, “It is not clear how the pup would have died on top of the rock due to any human-caused event, but it is possible that a large bull might have trampled the pup, though the location on top of a rock makes that scenario unlikely. Though this mortality was unobserved there seems to be a possible mechanism and timing related to our activity, thus we have claimed this mortality under our permit.”

In the PEIS mortality assessment tables, the observed mortality rate for pups during roundup and handling was 0.1 percent of the number of pups that were captured in the western DPS and 0.7 percent in the eastern DPS. These values were based on data from NMML’s 2000-2005 capture trips in the west and ADF&G’s 2001-2005 capture trips in the east. The two mortalities reported by NMML in 2008 may or may not have been caused by research-related disturbance on the rookeries. If we assume that both were the indirect result of research, the observed mortality rate for NMML’s capture efforts in 2007 and 2008 would be 2 out of 1,014 pups captured (536+478), or 0.2 percent. If only one was the indirect result of research, as reported by NMML, the observed mortality rate would be 0.1 percent, the same value used in the PEIS.

The 2007 annual report from ASLC (permit 881-1890) reported the capture of 54 pups on Chiswell Island, by hand or hoop net. Each pup was given gas anesthesia by a veterinarian and had a number of procedures performed on it (measurements, digital imaging, ultrasound, blood sample, skin biopsy, temporary pelage mark, and either hot brand or flipper tag). There were no injuries or mortalities observed at the time of the rookery visit or in following days through use of the remote video camera system on Chiswell.

In 2008, ASLC captured 62 pups on Chiswell and conducted very similar procedures as in 2007. No injuries were observed but two of the pups apparently did not reunite with their mothers. One of these was determined, through videographic analysis, to have been the young pup of a female that was also nursing a yearling (in such cases it is common for mothers to abandon pups in favor of unweaned yearlings).

ASLC concluded that this pup had already been abandoned by its mother before the research and branding event and that the research disturbance probably played no role in this situation. The other pup was observed (with the video camera system) to slide into the water the morning after the branding and struggled to haul out onto shore for more than 2 hours before it apparently drowned. This pup was probably 12 days of age and of normal weight and health. The identity of its mother was inferred by process of elimination and she was believed to be out foraging when the pup drowned. ASLC concluded: "It is unlikely that our research activities were the primary cause of E115's death as such losses to the surf are the most common source of mortality in young pups of this species. However, we cannot rule out our activities as a contributing factor in that death because the SSLs remained closer to the water after our departure from the island and the branding and sampling of this pup could have temporarily weakened it." This type of mortality would be unobserved in almost all other cases but the remote video camera system on Chiswell allows continuous monitoring without disturbance from researchers.

Non-pups

ADF&G (permit 358-1888) reported capturing 39 juveniles (5 months old) in November 2007 in Prince William Sound and re-capturing 15 of those animals in April 2008. All captures were made with the dive "noose" capture technique. Each animal was put into a capture box and transported to the research vessel for processing. Each was given gas anesthesia by a veterinarian and had a number of procedures performed on it (measurements, biopsies, other samples, tooth extraction, hot-brand, instruments attached, marker injection for physiological tests, stomach intubation, portable metabolic chamber, ultrasonic imaging). After a monitored recovery period, the animals were released. Three of the captured animals had injuries to permanent teeth that were attributed to capture activities. No other injuries or mortalities were observed. ADF&G notes that the median body condition of animals recaptured at 10 months of age was higher than the median condition of the original 39 captures at 5 months of age. Although these body condition measurements were not necessarily conducted for this purpose, the result indicates that the initial capture event did not compromise the ability of the recaptured juvenile SSLs to prosper.

Fadely et al. (2008) used telemetry and brand re-sight data to estimate the mortality rate from capturing and handling juvenile SSLs. This estimate included a component for animals that died during capture and anesthesia (3 out of 464 animals captured = 0.6 percent) and those that died after release (unobserved mortality). The early failure of telemetry signals (within 14 days of release) combined with the failure to re-sight the animal in the future was interpreted as a potential unobserved mortality. This method likely yields an overestimate of unobserved mortality due to the difficulty of re-sighting animals that travel over large distances and spend significant amounts of time in the water. The resulting estimated unobserved mortality rate was 1.6 percent. The combined observed and unobserved mortality estimate was thus about 2.2 percent. The authors point out that separate data sets provide an estimated mortality rate from natural causes as 2 percent of animals in these sex and age classes. The authors conclude that the estimated mortality due to capture and handling, which necessarily includes natural mortality, therefore represents a very small increase in risk to the animals involved. The observed mortality data used in this study was already incorporated into the PEIS mortality assessment tables. The assessment tables account for unobserved mortality in several places but the overall estimate of unobserved mortality used in the PEIS assessment is very similar to that estimated by Fadely et al. (2008).

The 2008 report from the ASLC on their Transient Juvenile Capture Program (permit 881-1890-2) describes the capture and transport of six juveniles in fall of 2007 and five juveniles in spring 2008. These animals were captured by the dive "noose" capture method, transported to the ASLC, and held there for up to three months to undergo a series of physiological and nutritional studies before their release back into the wild. There were an additional 17 animals captured during this program. One slipped the noose before it was brought on board, 8 were judged to be less than 12 months old and were immediately released, and 8 were processed on board the research vessel (gas anesthesia, various morphological, health, and physiological tests, tissue sampling, branding, and instrument attachment) and released. No serious injuries or mortalities were observed from any animals involved in this research, either in the field or after release from temporary captivity.

Mellish et al. (2007) assessed the potential impacts of surgically implanting life history transmitters (LHX) into 6 juvenile SSL in the ASLC Transient Juvenile Capture Program. They monitored post-surgery physiological recovery for up to eight weeks while the animals were in temporary captivity and then movement and diving behavior after their release using satellite telemetry. They found evidence for an acute-phase reaction in the first 2 weeks post-implant (elevated globulin and haptoglobulin) but body condition and blood parameters did not change significantly during the study period. After their release, all SSLs returned to their respective capture haul-outs. Shorter and shallower dives during the first week post-release suggested a possible recovery period similar to other non-LHX individuals released from temporary captivity. For all subsequent weeks, dive depth, duration, frequency, and dispersal distances of LHX animals were comparable to free-ranging individuals. The authors concluded that all physiological and behavioral responses to the implantation surgery were temporary in nature and that LHX transplantation is a viable alternative for long-term survival rate studies. The authors would like to extend use of the LHX implantation technology to free-ranging animals without the need for medium-term captivity. They would like to be able to capture animals, perform the surgery, hold the animals for a short period until they have recovered from the acute affects of the surgery, and then release them. This study is preliminary to the effort to establish specific risk values for this procedure. The mortality assessment tables included this type of procedure as a relatively high-risk procedure.

4.8.1.2 *Comparison of Authorized and Actual Takes With the PEIS Analysis*

The PEIS estimated the scope and types of research that would be requested by all potential research groups under the Preferred Alternative. As a proxy to allow an analysis of the potential mortality effects of the Preferred Alternative, this estimated scope of research was translated into specific numbers of takes in different research activity categories in the mortality assessment tables. The conclusions of the PEIS regarding the impact of research-related mortality on the population thus depended on this estimate of future requests for research permits. The question for this document is to determine whether the scope of research authorized since publication of the PEIS is consistent with the scope of work analyzed in the PEIS for the Preferred Alternative. For all research activity categories, the numbers of authorized takes in 2007 or 2008 was less than, and in most case much less than, the numbers of takes considered in the PEIS analysis of the Preferred Alternative.

4.8.1.3 *Comparison of mortality assessments*

For the Western DPS, the PEIS estimated that the scope of research defined as the Preferred Alternative would lead to 29.8 mortalities per year (5.4 observed mortalities and 24.4 unobserved mortalities). This was 12.7 percent of PBR (234 animals). The scope of research authorized after the ROD was issued (2007-2009), assessed through the same mortality assessment tables as used in the PEIS, would result in an estimated 21.5 mortalities per year (5.9 observed mortalities and 15.7 unobserved mortalities), which is 9.2 percent of PBR.

For the Eastern DPS, the PEIS estimated that the Preferred Alternative would lead to 25.5 mortalities per year (7.0 observed mortalities and 18.5 unobserved mortalities). This was 1.3 percent of PBR (2000 animals). The scope of research authorized after the ROD was issued (2007-2009), assessed through the same mortality assessment tables as used in the PEIS, would result in an estimated 12.8 mortalities per year (0.9 observed mortalities and 11.9 unobserved mortalities), which is 0.6 percent of PBR.

4.8.1.4 *PBR as a metric for mortality assessment*

The calculation of PBR is defined in the MMPA, where it was intended to be an upper limit guideline for fishery-related mortality for each species and/or management stock. The PEIS used PBR as a metric to determine the significance of estimated mortality due to research. For each alternative, the estimated mortality, including both observed and unobserved mortalities, was compared to PBR for each DPS (management stock). For the Western DPS of SSL, PBR was 234 animals at the time the PEIS was published. The overall population estimate for the Western DPS has not been updated since that time, hence the calculation of PBR in the most recent stock assessment report (Angliss and Outlaw 2008) is the same as was used in the PEIS. PBR for the Eastern DPS was 2,000 animals at the time the PEIS was published and 2,006 animals in the most recent stock assessment report (Angliss and Outlaw 2008). The metric used to determine the significance of research-related mortality in the PEIS is the same for the Western DPS. For the Eastern DPS, it has changed such that a given level of research-related mortality would be less, relative to PBR, than what was considered in the PEIS.

4.8.1.5 *Assessment of Sub-Lethal Effects Due to Research*

This is the second part of the analysis of effects considered in the PEIS, focusing on how research may affect animals in ways that do not lead to mortality, particularly the effects of research on the reproductive success of animals. The potential mechanisms for sub-lethal effects on reproduction were identified in the PEIS:

- Physiological responses to stress that cause failure of embryonic implantation or re-absorption of fetuses.
- Injury to the reproductive organs or damage to hormonal regulation that leads to temporary or permanent sterility.
- Changes in maternal behavior that reduces feeding of pups, affecting growth rates.
- Delayed sexual maturation due to slow growth or poor health.
- Loss or shrinkage of territory, and therefore access to mates.

However, the PEIS states: "Direct evidence for the occurrence of most of these mechanisms in SSLs is weak or lacking altogether. Research designed to specifically measure the sub-lethal effects of different research techniques have not been conducted for most activities considered in this EIS." There have been no direct tests of research-related effects on reproductive success since the PEIS was published. Efforts to measure long- or medium-term effects on SSLs have involved re-sight data on branded animals or animals re-captured later in life. The PEIS cites an analysis of juvenile SSLs that had been captured and branded as pups. These juveniles did not show any statistical difference in mass or length from juveniles that had not been branded as pups, indicating no measurable effect of branding on growth rates.

Although it is possible to track the reproductive success of females that have been permanently marked (branded), there is very limited data on the long-term reproductive success of non-marked animals for comparison. The potential for sub-lethal effects of research therefore remains unknown, as concluded in the PEIS.

4.8.1.6 *Assessment of Beneficial Contributions Toward Conservation Objectives*

This third part of the analysis presented in the PEIS discusses how well the scope of research represented under each alternative would be able to address information needs for taking management actions that would promote recovery and conservation of the species, as defined by the goals identified in the Draft

SSL Recovery Plan published in 2006. Since the PEIS was published in 2007, NMFS solicited and incorporated public comments on the Draft Recovery Plan and published the Final Revised Recovery Plan for SSLs (NMFS 2008). The issue regarding this part of the PEIS assessment is whether the research goals identified in the Final SSL Recovery Plan are significantly different from those of the Draft SSL Recovery Plan that were used in the PEIS.

The Draft Recovery Plan included the following:

"ACTIONS NEEDED: The Plan identifies 78 substantive actions needed to achieve recovery of the western DPS by addressing the broad range of threats, and it is geared toward three main objectives: (1) the collection of information on status and vital rates, (2) research programs to collect information on the remaining threats to recovery, including fisheries and other anthropogenic factors, and (3) the implementation of conservation measures to remove impacts of remaining threats to recovery. The Plan highlights four actions (below) that are especially important to the recovery program for the western DPS:

- Continue population monitoring and research on the key threats potentially impeding SSL recovery (Action 1.1.1 and others).
- Maintain current fishery conservation measures (Action 2.6.6).
- Design and implement an adaptive management program to evaluate fishery conservation measures (Action 2.6.8).
- Develop an implementation plan (Action 1.5).

After input from the public and various agencies, the wording of this section in the Final SSL Recovery Plan was slightly different (see italics) but did not change the focus of the actions:

"ACTIONS NEEDED: The Plan identifies 78 substantive actions needed to achieve recovery of the western DPS by addressing the broad range of threats. These actions are aimed at addressing three main objectives: (1) the collection of information on status and vital rates, (2) research programs to collect information on the remaining threats to recovery, including natural and anthropogenic factors, and (3) the implementation of conservation measures to remove impacts of anthropogenic threats to recovery. The Plan highlights four actions (below) that are especially important to the recovery program for the western DPS:

- Continue population monitoring and research on the key threats potentially impeding sea lion recovery (Action 1.1.1 and others)
- Maintain current or equivalent level of fishery conservation measures (Action 2.6.6)
- Design and implement an adaptive management program to evaluate fishery conservation measures (Action 2.6.8)
- Develop an implementation plan (Action 1.5)

The PEIS listed the recommended actions described in the Draft SSL Recovery Plan to meet its conservation objectives. All of these recommended actions are directly or indirectly dependent on SSL research. The list of recommended actions in the Final Recovery Plan is identical to that listed in the Draft Recovery Plan used in the PEIS analysis.

4.8.1.7 *Conclusion Regarding the Need to Reassess the PEIS Alternatives*

This document summarizes information relevant to the PEIS analysis of alternatives that has become available since the PEIS was published in 2007. The majority of this new information relates to the assessment of injury and mortality in the risk assessment tables.

While there were a few slight variations among research groups in the proportions of animals responding to different activities, the frequency of observed injuries and mortalities were consistent with the values used in the PEIS assessment. The number of takes authorized under current permits is lower for most research activity categories than the corresponding number of takes assessed for the Preferred Alternative in the PEIS. The estimated mortalities from the currently authorized research programs are well below the estimated mortalities from the Preferred Alternative. The current level of authorized research is therefore well within the scope analyzed for the Preferred Alternative in the PEIS.

There has been no new information published or made available that measures sub-lethal effects of research. The potential for sub-lethal effects of research therefore remains unknown, as concluded in the PEIS.

The last part of the PEIS assessment was to determine how well the scope of research represented under each alternative would be able to address information needs identified in the SSL Recovery Plan. The list of research-related actions in the Final Recovery Plan is identical to that listed in the Draft SSL Recovery Plan used in the PEIS analysis. There is therefore no reason to reassess the ability of the Preferred Alternative to meet the research objectives of the Final Recovery Plan.

4.8.2 Northern Fur Seal

The PEIS analysis of effects of research on NFSs closely followed the format used for SSLs, including mortality assessment tables, discussion of potential sub-lethal effects on reproductive success, and an analysis of how authorized research under each alternative would be able to address research needs identified in the Draft Conservation Plan for NFS (NMFS 2006b). For each type of effects analysis, this section will compare the scope of research currently authorized for NFS research with the scope of research analyzed under the PEIS Preferred Alternative.

4.8.2.1 *Mortality Assessment Tables*

The assessment of research-related injury and mortality is the first part of the analysis presented in the PEIS. The PEIS describes the basis and sources of information for the specific rates of behavioral responses, injury, and mortality used in the mortality assessment tables. As was the case with SSL, there have been few studies designed to examine research effects on NFS. Data for most reaction rates were not available and were estimated based on the professional judgment of highly experienced scientists at NMML. In a few cases, data from research trip reports were used in the assessment tables. Unlike the situation for SSL, there have been no specific studies made and no papers have been published on the effects of research on NFS since the PEIS was published. The annual reports that have been filed for work conducted in 2007 and 2008 do not contain any observations or data that contradict or modify the reaction rates used in the PEIS assessment tables. There is therefore no basis to adjust the structure or values used in the assessment tables.

4.8.2.2 *Comparison of Authorized and Actual Takes with the PEIS Analysis*

The PEIS estimated the scope and types of research that would be requested by all potential research groups under the Preferred Alternative. As a proxy to allow an analysis of the potential mortality effects of the Preferred Alternative, this estimated scope of research was translated into specific numbers of takes in different research activity categories in the mortality assessment tables. The conclusions of the PEIS regarding the impact of research-related mortality on the population thus depended on this estimate of future requests for research permits. The question for this document is to determine whether the scope of research authorized since publication of the PEIS is consistent with the scope of work analyzed in the PEIS for the Preferred Alternative. Table 4.3 compares the number of takes for the Eastern Pacific stock of NFS in different research activity categories that were considered in the PEIS mortality assessment tables, the number of takes authorized in all current research permits, and the numbers of takes reported from those permits in 2007. Not all permits have reported takes for 2008 yet so these totals are not reported. For most research activity categories, the numbers of authorized takes was less than the numbers of takes considered in the PEIS analysis of the Preferred Alternative. For all research activity categories, the number of actual takes in 2007 was much less than the numbers of takes considered in the PEIS analysis of the Preferred Alternative. There was relatively little field work conducted on NFSs in 2007 because of funding issues that prevented continuation of planned projects.

4.8.2.3 *San Miguel Stock*

In the PEIS analysis of effects on the San Miguel stock of NFSs, the Preferred Alternative was assumed to be the same scope of research as what existed under the status quo conditions. The San Miguel stock is not listed under the ESA and is not listed as depleted under the MMPA so there is no conservation plan for this stock. The research plan for this stock is therefore driven by normal stock assessment needs outlined in the MMPA rather than needs for recovery. No additional analysis is warranted in this document.

4.8.2.4 *Comparison of mortality assessments*

For the Eastern Pacific stock of NFSs, the PEIS estimated that the scope of research defined as the Preferred Alternative would lead to 67 mortalities per year (11.5 observed mortalities and 55.5 unobserved mortalities). This was 0.4 percent of PBR (15,262 animals). The scope of research authorized after the ROD was issued (2007-2009), assessed through the same mortality assessment tables as used in the PEIS, would result in an estimated 42.6 mortalities per year (15 observed mortalities and 27.6 unobserved mortalities), which is 0.3 percent of PBR.

4.8.2.5 *PBR as a metric for mortality assessment*

As described in the SSL account, the PEIS used PBR as a metric to determine the significance of estimated mortality due to research. For each alternative, the estimated mortality, including both observed and unobserved mortalities, was compared to PBR for each management stock. For the eastern Pacific stock of NFS, PBR was 15,262 animals at the time the PEIS was published and is still the same value in the most recent stock assessment report (Angliss and Outlaw 2008). The metric used to determine the significance of research-related mortality in the PEIS has therefore remained the same for this stock.

4.8.2.6 *Assessment of Sub-Lethal Effects Due to Research*

This is the second part of the analysis of effects considered in the PEIS, focusing on how research may affect animals in ways that do not lead to mortality, particularly the effects of research on the reproductive success of animals. However, there is currently no direct evidence for potential mechanisms of research-related effects in NFSs. Research designed to specifically measure the sub-lethal effects of different research techniques have not been conducted on NFSs. The potential for sub-lethal effects of research therefore remains unknown, as concluded in the PEIS.

4.8.2.7 *Assessment of Beneficial Contributions toward Conservation Objectives*

This is the third part of the analysis presented in the PEIS. It discusses how well the scope of research represented under each alternative would be able to address information needs for taking management actions that would promote recovery and conservation of the species, as defined by the goals identified in the Draft Conservation Plan for NFS published in 2006. Since the PEIS was published in 2007, NMFS solicited and incorporated public comments on the Draft Conservation Plan and published the Final Revised Conservation Plan for NFS (NMFS 2007). The issue regarding this part of the PEIS assessment is whether the research goals identified in the Final Conservation Plan are significantly different from those of the Draft Conservation Plan that were used in the PEIS.

The goal of the NFS Conservation Plan is to promote the recovery of the eastern Pacific NFS stock to a level appropriate to justify removal from MMPA depleted listing. NMFS will focus management using a science-based ecosystem approach to determine how and when to implement and monitor the conservation actions identified in the plan. NMFS noted that as of the writing of the Draft Conservation Plan, the stock was declining, and stopping the decline was of paramount importance. The Draft Conservation Plan proposed a series of conservation objectives and action items to implement these objectives. All of these recommended actions are directly or indirectly dependent on NFS research. The list of recommended actions in the Final Conservation Plan is the same as that listed in the Draft Conservation Plan used in the PEIS analysis.

4.8.2.8 *Conclusion Regarding the Need to Reassess the PEIS Alternatives*

There have been no new studies published or reports from the research community regarding the direct or indirect effects of research on NFSs since the PEIS was published. There is therefore no basis to adjust the structure or values used in the PEIS mortality assessment tables. Table 4.3 shows that the number of takes authorized under current permits is lower for most research activity categories than the corresponding number of takes assessed for the Preferred Alternative in the PEIS. Finally, the estimated mortalities from the currently authorized research programs and the actual scope of work that has been conducted in 2007 and 2008 are well below the estimated mortalities from the Preferred Alternative. The current level of authorized research is therefore well within the scope analyzed for the Preferred Alternative in the PEIS.

There has been no new information published or made available that measures sub-lethal effects of research. The potential for sub-lethal effects of research therefore remains unknown, as concluded in the PEIS.

The last part of the PEIS assessment was to determine how well the scope of research represented under each alternative would be able to address information needs identified in the NFS Conservation Plan. The list of research-related actions in the Final Conservation Plan is identical to that listed in the Draft Conservation Plan used in the PEIS analysis. There is therefore no reason to reassess the ability of the Preferred Alternative to meet the research objectives of the Final Conservation Plan.

4.8.3 Other ESA-Listed Species

Section 4.8.3 of the PEIS described the effects of the proposed research on non-target ESA listed species. Although there were updates to the status of four species (Cook Inlet beluga whale, ringed, spotted, and bearded seals--Section 3.2.4), the effects of the research on these species has not changed. During research, encounters with these species are rare as study areas and species habitat do not overlap.

4.9 SOCIAL AND ECONOMIC ENVIRONMENT

Section 4.9 of the PEIS analyzes the likely impacts to the social and economic environment as a result of the proposed alternatives outlined in the PEIS. Specifically, this included how community members would be affected by each alternative through the interpretation of how different SSL and NFS research methodologies would alter existing interactions or result in new levels or types of interactions between visiting research staff and local residents. This included a discussion dealing with the effects each proposed alternative may have on subsistence harvesters. Also included was a discussion concerning direct community interactions as they related to the local economy, education, and sociocultural environment. Finally, Section 4.9 of the PEIS included an analysis of disproportionate impacts that may be experienced by minority and/or low-income populations.

It should be noted that, despite updated subsistence harvest and commercial fishing information having been obtained since the publication of the PEIS, the impacts of the various alternatives have not changed. Thus, updates are not warranted.

4.10 ECONOMIC EFFECTS OF FEDERAL FUNDING FOR SSL AND NFS RESEARCH

4.10.1.1 *Economic Effects of Changes in Research Expenditures*

The PEIS stated that the Preferred Alternative could possibly make SSL and NFS research more attractive to both researchers and sources of research funding by creating opportunities for more advanced marine mammal studies. However, the PEIS also noted that it was uncertain whether a proposal for an extensive research program would actually lead to higher funding levels. Fiscal, political, institutional and other factors affect research funding, and to at least some extent, these complex and unpredictable factors exist apart from the specific types of SSL and NFS research techniques and level of research effort permitted. As described in Section 3.6.1, funding for SSL research and management decreased in 2007 and 2008. The 2008 funding level was approximately one-fifth of the 2001 level. This substantial reduction in the amount of money available for employment and purchases of capital and expendable items has had a negative effect on funding recipients and broader regional economies.

4.10.1.2 *Economic Effects of Changes in Research Output*

According to Section 4.8.1, the conservation objectives and action items to implement these objectives in the Final Conservation Plans for SSL and NFS are the same as those listed in the Draft Conservation Plans used in the PEIS analysis. However, the extent to which the conservation objectives were achieved has not been assessed. Consequently, the effect on the welfare of that segment of the American public that values the protection of SSL and NFS populations can not be determined.

Section 4.8.1 indicates that the estimated SSL and NFS mortalities from the currently authorized research programs and the actual scope of work that has been conducted in 2007 and 2008 are well below the estimated mortalities from the Preferred Alternative. Consequently, the likelihood of a loss of human welfare resulting from the deaths of individual animals due to research would be lower than the likelihood under the Preferred Alternative.

5.0 NEPA COMPLIANCE AND IMPLEMENTATION AND RECOMMENDATIONS

This section summarizes new information that has become available since the PEIS and ROD were published in June 2007. The purposes of Chapter 5 in the PEIS were to:

- explain the procedures that will be used to implement future NEPA compliance on permitting and grant activities addressed in the PEIS
- document actions underway to address concerns raised during preparation of this PEIS regarding compliance with the Animal Welfare Act (AWA)
- make recommendations for further actions associated with SSL and NFS research that have been suggested during the course of the EIS process.

The original PEIS Chapter 5 can be downloaded from the NMFS website at: http://www.nmfs.noaa.gov/pr/permits/eis/steller.htm

In 2007, NMFS convened a panel of independent experts with expertise in endangered species recovery planning, marine mammal research, population modeling, and veterinary medicine. The panel conducted a review of the current SSL and NFS scientific research permit program and made recommendations on how to make improvements to the permitting process for these species, including coordination and monitoring of research. Specifically, NMFS asked the panel to review past and current research on SSLs and NFSs and, in consideration of conservation and management needs for these species, and criticisms of the permitted research, make recommendations on four overarching areas related to implementation of the research permit program: (1) type of research activity or project; (2) research techniques or protocols; (3) coordination among permit holders; and (4) monitoring research.

The panel provided a final report to NMFS in October 2008, which included a list of recommendations for improving the scientific research permit process. Some recommendations were specific to the permit program for SSLs and NFSs, while others were broader and included a framework that could be applied to permits for other ESA species. The panel also had recommendations for NMFS in general, rather than the permit program specifically. The panel recommended the following related to the permit program as operated through the PR1:

- The Permits Division should not attempt to operate the research permit evaluation process using only their in-house assets;
- The Permits Division should review, and modify if needed, permit reporting requirements and procedures for storing permit report data;
- The Permits Division should use existing mechanisms, or if necessary establish additional mechanisms, to enforce permit provisions and, if necessary, revoke, suspend, or modify permits;
- The Permits Division should require that researchers participate in coordination efforts as a condition of their permit;
- The Permits Division should participate in the recovery team/recovery plan process; and
- The Permits Division should ensure that any permitted research complies with all relevant legislation and policies (ESA, MMPA, AWA).

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APPENDIX A List of New Publications, Presentations and Reports

SSL Articles

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Appendix C

Requirements for Obtaining a Grant or Permit for Research on Protected Species

National Marine Fisheries Service Policy and Guidance for Implementation of the Steller Sea Lion and Northern Fur Seal Research Permit Program under the Preferred Alternative of the 2007 Final Programmatic EIS

Prepared For Use by
Headquarters Office of Protected Resources – Permits Division

February 2009

Contents

1.0 What is the purpose of this document?

This document establishes the National Marine Fisheries Service's (NMFS) policy for implementation of the preferred alternative and the recommendations in Chapter 5 of in the Steller Sea Lion and Northern Fur Seal Research Final Programmatic Environmental Impact Statement (PEIS) (NMFS 2007). This document also provides guidance for issuance of permits for research on Steller sea lions (*Eumetopias jubatus*) and northern fur seals (*Callorhinus ursinus*).

The purpose of establishing such policies and guidance is to promote consistent compliance with the PEIS and the National Environmental Policy Act (NEPA) for

- reviewing permit applications and reports
- coordinating research
- monitoring effects of research
- monitoring effectiveness of research (in contributing to purpose and need in PEIS)

This document does not cover the following three items in Chapter 5 of the Final PEIS because they are outside the scope of the permit program: (1) a "formalized research implementation plan" that prioritizes categories of research activities from the Recovery and Conservation Plans, (2) a policy for Animal Welfare Act "Compliance and Establishment of Best Management Practices," or (3) policy and guidance for coordination with Alaska Native Organizations. These items are more appropriately addressed through actions of the NMFS Alaska Regional Office, the individual researchers and research institutions, and a combination of the Regional Office and individual researchers, respectively.

1.1 Who should use this document?

The Director, Office of Protected Resources, has authority to issue permits under section 104 of MMPA and Section 10(a)(1)(A) of ESA and responsibility to ensure research is consistent with statutory and regulatory requirements. Permit analysts and decision makers in the Office of Protected Resources should refer to this document when reviewing applications for permits for research on Steller sea lions and northern fur seals.

Note that this document is not intended for permits that authorize takes of Steller sea lions or northern fur seals that are only incidental to research on another marine mammal species or other threatened and endangered species, or for permits that authorize only import, export, or receipt of marine mammal parts.

1.2 When is this document applicable?

The policies and guidance in this document are effective immediately, unless otherwise indicated. This document will remain in effect while NMFS issues permits under the 2007 Final PEIS. NMFS will review this document during internal scoping to establish its relevance if new or additional NEPA documentation is required for the Steller sea lion and northern fur seal research programs. NMFS will also review this document at least every five years to evaluate its operational effectiveness. In addition, NMFS will review this document if there are changes in the status of the species or stocks for which it is applicable, or if there is a substantial increase in available resources for, or interest in, research on these species.

NMFS will revise this document as needed to improve effectiveness, and when needed to comply with changes in related statutes, regulations, policy directives, and operational programs. Review and revision will be conducted by the Chief, Permits Division. NMFS will evaluate how effectively this policy and guidance

- enhances determinations and documentation of the conservation and recovery benefits of the permitted and funded research
  - permits are consistent with the purposes and policies of the Marine Mammal Protection Act (MMPA; 16 U.S.C 1361 et seq.) and Endangered Species Act (ESA; 16 U.S.C. 1531 et seq.)
  - permit applications are scored consistently among permit analysts
  - application review documents clearly articulate and support rationale for permit issuance or denial
  - limits on permit amendment requests allow permit program staff adequate time to evaluate and document compliance and environmental impacts

2.0. Background

Steller sea lions have been protected under the MMPA since its enactment in 1972. They have also been protected under the ESA since being listed as threatened[1] throughout their range in 1990. In 1997, NMFS classified Steller sea lions as two distinct population segments under the ESA. NMFS listed the segment of the population west of 144°W longitude as endangered[2], and maintained the threatened listing for the remainder of the population in the United States.[3] The reclassification was primarily due to information that indicated two genetically differentiated population segments, a continued decline in abundance trends, and population viability analysis models that predicted a 65-100% probability of extinction for the population from Kenai Peninsula to Kiska Island within 100 years if the trends continued.

NMFS recognizes two stocks of northern fur seal under the MMPA: the San Miguel Island Stock and the Eastern Pacific Stock. The Eastern Pacific Stock of northern fur seals is listed as "depleted" under the MMPA, meaning NMFS has determined this population to be below its optimum sustainable population[4].

In 2001-2002, Congress appropriated approximately $80 million to perform research into the causes of the decline of Steller sea lions and to develop conservation and protective measures to ensure Steller sea lion recovery.[5] These funds were also to be used to "develop and implement a coordinated, comprehensive research and recovery program for the Steller sea lion." NMFS

[1] The term "threatened species" means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
[2] The term "endangered species" means any species which is in danger of extinction throughout all or a significant portion of its range.
[3] 62 FR 24345, May 5, 1997
[4] The MMPA defines "optimum sustainable population" for a marine mammal stock as the number of animals that will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element.
[5] See the notice of availability of funds for the Steller Sea Lion Research Initiative, 66 FR 15842, March 21, 2001; see also FY2001 Consolidated Appropriations Act, Pub. L. No. 106-554, Div. A, Chap. 2, Sections 206 and 209, 114 Stat. 2763, 2763A-175 through 2763A-179 (2000).

allocated a portion of these funds through a competitive grants program called the Steller Sea Lion Research Initiative (SSLRI). This increased Congressional funding resulted in a substantial increase in the number of permit applications to conduct research on Steller sea lions.

2.1 History of NEPA process for research permits

During the public review of the research permit applications submitted for the SSLRI, NMFS received comments from the Marine Mammal Commission, the Humane Society of the United States (HSUS) and others expressing concerns about the increased scope and magnitude of the research and the potential for adverse impacts on the species. NMFS completed an environmental assessment[6] in June 2002 to evaluate the potential impacts to the environment (including Steller sea lions) from the increased research activities under the SSLRI. NMFS determined that issuance of the permits was not likely to result in significant adverse impacts if permits were limited to a term of two years and provided certain mitigation and monitoring measures were followed.

As an additional mitigation for potentially significant adverse impacts of research, NMFS committed to development of a research coordination and monitoring plan to ensure that future research did not result in significantly adverse impacts, and to collect information on the effects of research for improving future environmental reviews.

NMFS prepared a new environmental assessment in May 2005 and extended or re-issued permits issued in 2002. In July 2005, the HSUS filed suit, alleging that NMFS permitted activities could have a significant, irreversible impact on the ability of Steller sea lions to survive. The HSUS also alleged that NMFS should have prepared an environmental impact statement (EIS) rather than an environmental assessment, because of this potential for significant adverse impacts from the research activities.

The HSUS further requested that NMFS conduct a workshop to: identify the key recovery plan goals requiring additional research; establish an appropriate sampling design for survey, behavioral, and physiological research; develop a strategic plan and study design to ensure a cohesive approach to research; and develop quantitative models of energetics, life history, and population dynamics of Steller sea lions.

Some issues HSUS proposed for the workshop are beyond the scope of the permit program. NMFS issues permits in response to applications, and does not assign research projects or methods to permit holders. Rather, the permit program evaluates whether a particular application satisfies the issuance requirements of applicable laws. However, NMFS agreed that the permit program's review of applications would benefit from independent identification of appropriate sampling designs and methodologies.

In May 2006, the District Court found that NMFS should have prepared an EIS, remanded the EA back to NMFS, vacated the research permits issued under the EA, and ordered NMFS to prepare an EIS before issuing new permits. NMFS had already begun preparing an EIS, and the

[6] Prepared to comply with the National Environmental Policy Act (42 U.S.C. 4321 et seq.).

court's order effectively accelerated the timeline because no research requiring a permit could be conducted until completion.

NMFS completed a Programmatic EIS for the Steller sea lion and northern fur seal research programs and issued its Record of Decision in June 2007. NMFS selected the Preferred Alternative (Alternative 4: Research Program with Full Implementation of Conservation Goals) as the approach to issue grants and permits for scientific research on SSL and NFS. This alternative allows the agency to fully implement the recommendations in the species' conservation and recovery plans and does not limit the types of methods, locations, timing, sample sizes, etc. The Preferred Alternative includes all research activities needed to address all information objectives identified for both species of concern. This alternative includes the same types of research described in the status quo alternative, and also allows for activities that have not been authorized under the status quo, including new permits and permit amendments that were pending as of January 2006. It also allows for techniques and activities that have not been previously requested or authorized, including intentional lethal take.

NMFS limited implementation of the Preferred Alternative by limiting duration and scope of the research permits to span three summer field seasons, with additional limits on research on pups during the first permit year, while engaging in a program review. The program review included convening an independent panel to assess the effectiveness of the research program. NMFS determined that the research permit program would benefit from a clearly articulated decision framework to ensure that research activities permitted under the MMPA and ESA would be expected to promote the conservation and recovery of the species while minimizing adverse effects of the research on the subject species.

2.2 Summary of Independent Panel Recommendations

In 2008, NMFS convened a panel of independent experts with expertise in endangered species recovery planning, marine mammal research, population modeling, and veterinary medicine. The panel conducted a review of the current Steller sea lion and northern fur seal scientific research permit program. The panel was asked to recommend improvements to the permitting process for these species, including coordination and monitoring of research. Specifically, NMFS asked the panel to review past and current research on Steller sea lions and northern fur seals and, in consideration of conservation and management needs for these species, and criticisms of the permitted research, make recommendations on four overarching areas related to implementation of the research permit program: (1) type of research activity or project, (2) research techniques or protocols, (3) coordination among permit holders, and (4) monitoring research. The Terms of Reference provided to the panel are included in Appendix A.

The panel provided a final report to NMFS in October 2008, which included a list of recommendations for improving the scientific research permit process. The complete report is included in Appendix B. Some recommendations were specific to the permit program for Steller sea lions and northern fur seals, while others were broader and included a framework that could be applied to permits for other ESA species. The panel also had recommendations for NMFS in general, rather than the permit program specifically. This document does not address recommendations that are not specific to the permit program.

The panel recommended the following related to the permit program as operated through the Permits Division:

- The Permits Division should not attempt to operate the research permit evaluation process using only their in-house assets.
- The Permits Division should review, and modify if needed, permit reporting requirements and procedures for storing permit report data.
- The Permits Division should use existing mechanisms, or if necessary establish additional mechanisms, to enforce permit provisions and, if necessary, revoke, suspend, or modify permits.
- The Permits Division should require that researchers participate in coordination efforts as a condition of their permit.
- The Permits Division should participate in the recovery team/recovery plan process.
- The Permits Division should ensure that any permitted research complies with all relevant legislation and policies (ESA, MMPA, AWA).

This document addresses and incorporates recommendations of the panel as appropriate. Issues related to the permit evaluation process, including compliance with all applicable legislation and policies, are discussed in Section 3.1. Permit reporting and enforcement issues are discussed in Section 3.4. Permit process requirements related to coordination among researchers are discussed in Section 3.3.

Note, this document does not address Permits Division participation in the recovery team or plan process for Steller sea lions and northern fur seals because those processes are not ongoing at this time. Should NMFS decide to revise the Steller sea lion Recovery Plan or northern fur seal conservation plan, the Permits Division will be involved early in the process to ensure that the structure and content of the plans facilitates the research permit process.

2.3 Other laws and policies affecting implementation

In addition to the substantive requirements of the MMPA and ESA, there are procedural requirements under NEPA, the Administrative Procedure Act (APA), and various policy directives. Whereas the MMPA and ESA require NMFS to make specific findings in consideration of the purposes and policies of the statutes, NEPA and APA require NMFS to document its processes. NEPA requires NMFS to consider and publicly disclose the potential impacts of permit issuance on the "human environment." The APA requires NMFS to maintain a thorough written, publicly available record demonstrating that the agency: (1) acted within the scope of its authority; (2) adequately explained its decision; (3) based its decision on facts in the administrative record; and (4) considered the relevant factors. One policy directive dictates how NMFS responds to permit violations and another specifies how NMFS evaluates the appropriate level of NEPA documentation.

The requirements of the MMPA and ESA are addressed in Section 3.1 regarding the application review policy and guidance. The requirements of NEPA are addressed also in Section 3.1 regarding documenting the appropriate level of NEPA analysis for each application. The requirements of APA are also addressed in these same sections regarding the type of documentation to be prepared when processing applications.

NMFS Policy Directive 02-201. NMFS established a policy for processing applications and suspending permitted activities when a permit holder violates the permit, the regulations, the MMPA, or the ESA: *Policy to Establish a Standardized Procedure Concerning the Processing of Applications for Permits and the Suspension of Activities Pursuant to Existing Permits Issued Under the MMPA* (effective June 6, 1975). This policy directive is applicable to research permits NMFS issues under the MMPA, including those for which this document is applicable. Under this policy directive, NMFS

- will not process permit applications from applicants who are under investigation for, have been formally charged either criminally or administratively with an alleged violation of the MMPA or ESA, the regulations, or permit conditions, or have been convicted of or assessed a penalty for such violations, or have disposed of charges by a civil compromise.
- will initiate actions to suspend permits, in accordance with applicable regulations, held by persons under investigation or officially charged with a violation.
- will not issue permits if persons named in the application as participants in the research are under investigation or officially charged until the matter has been resolved or the person's name is stricken from the application.
- will consider each such application on its merits, taking into consideration the circumstances of the violation and the severity of the penalty imposed, if a permit applicant, person working under a permit, or person included as a participant in permitted activities has been found guilty of a violation, or has disposed of a Notice of Violation,

NMFS Policy Directive 30-131. NMFS established a policy delegating authority for determining the appropriate level of NEPA documentation: *Delegation of Authorities for Completing NEPA Documents* (effective March 5, 2007). This policy directive, along with an accompanying Quality Assurance Plan, outlines the requirements for document preparation, review and approval. Under this policy directive, NMFS developed a Quality Assurance Plan (QAP) for ensuring consistency with the policy directive. Among other things, the QAP requires an initial internal scoping process to ensure there are no review-related delays or surprises regarding the level of NEPA documentation. NMFS must prepare an Internal Initial Scoping Document (IISD) to document the appropriate level of NEPA analysis for each application. The IISD will document the internal coordination and consultation processes for evaluating whether individual applications are consistent with the Preferred Alternative or if additional NEPA analysis is required prior to permit issuance. An example of the information to be considered in the IISD process is in Appendix C, which includes a template for the IISD memo.

3.0. Policy and guidance

This section identifies policies NMFS will follow for review of research permit applications, coordination of research, monitoring effects of research, and monitoring effectiveness of the research permits. This section also includes specific guidance for implementing these policies. NMFS will adhere to this policy and guidance for all permit decisions for which this document is applicable, as outlined in Section 1.1.

3.1 Permit application review

The statutory and regulatory criteria for issuance of permits for research on marine mammals and ESA-listed species are effectively a risk-benefit analysis. They require permit applicants to demonstrate, or NMFS to find on the basis of the information provided by the applicant, that the adverse effects of the research will not disadvantage the affected species (risk) and will have a substantial likelihood of contributing to conservation of the affected species (benefit). Evaluation of the information provided by the applicant is somewhat subjective, as can be expected with any review of the type of qualitative information commonly provided by applicants in support of their permit request.

NMFS will use a clearly articulated decision framework in the application review process to promote conservation and recovery of the species. In addition to specific investigations that address information needs outlined in Recovery or Conservation Plans, certain types of basic population monitoring are essential to inform NMFS's management decisions related to conservation and recovery of the species. Permits for these types of activities would also be considered for permitting, consistent with the decision framework.

Decision framework. Permit applicants respond to application questions corresponding to statutory and regulatory issuance criteria. To facilitate more objective and consistent application review across permit reviewers, NMFS has developed a decision framework and guidance for rating these responses. The specific guidance, including reviewer score sheets, is included in Appendix D. All applications for permits, including permit amendments, will be reviewed using this guidance, which will also require reviewers to document in writing the findings of their review relative to the issuance criteria. Note that the term "reviewers" here is limited to Permits Division staff: applications are also sent to NMFS Science Center and Regional staff, as well as the Marine Mammal Commission, for review and comment. These external reviewers may, but are not required to use the same guidance or process for their reviews and may have established review processes of their own.

Section 7 consultations. As part of the application review and internal scoping processes, the Permits Division will evaluate the appropriate level of ESA interagency consultation required for issuance of a given permit. No additional ESA consultation would be initiated for applications that are determined consistent with the Preferred Alternative and all applicable issuance criteria because the Biological Opinions completed for full implementation of the Preferred Alternative will satisfy the consultation requirement. The exceptions to this would be that re-initiation of consultation is required if: (1) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (2) the identified action is subsequently modified in a manner that causes an effect to the listed species that was not considered in the Opinion; or (3) a new species is listed or critical habitat designated that may be affected by the identified action.

NEPA documentation. In addition to review of applications for compliance with applicable statutory and regulatory permit issuance requirements, the Permits Division will complete an Internal Initial Scoping Document (IISD) to document the appropriate level of NEPA analysis for each application. (See Appendix C.) If NMFS determines additional NEPA analysis is required (e.g., supplemental EIS, tiered environmental assessment), applications may also require further ESA consultation. In reviewing such applications, NMFS will consider whether the proposed permit, as compared to the information considered in the Biological Opinions for full implementation of the Preferred Alternative, triggers any of the three conditions for re-initiation of consultation listed above.

Mortality risk assessment. Chapter 5 of the Final PEIS indicated that permit review would include applying the mortality estimate method outlined in Chapter 4 of the document. Chapter 4 of the Final PEIS describes a quantitative method for assessing the mortality risk (observed and unobserved) for various research activities. To compare the effects of alternatives in the PEIS, NMFS's National Marine Mammal Laboratory (NMML) grouped research activities into five risk categories and assigned "predicted" mortality rates to these categories. This method of risk assessment relies on assumptions about how animals will react to various research activities and estimates of the numbers of animals that would die or be injured as a result. There is little quantitative information on the effects of most research activities. The assumptions and estimates were based on anecdotal observations and the professional opinions of researchers at NMML.

Permits issued in 2007 required researchers to collect data on the effects of research activities by requiring researchers to monitor animals post-research. While new studies directed at evaluating research effects have not been conducted, NMML completed evaluation of data from previous field work. NMFS will continue to require researchers to collect data on the effects of research as a condition of the research permits. Until there is sufficient data or information to develop a more robust mortality risk assessment method, NMFS will limit research-related mortality to the levels permitted in 2007: below 10% of potential biological removal for each stock. These mortalities will be allocated among research permit applicants based on the types of research activities and numbers of takes requested.

3.2 Permit amendment limitations

NMFS will limit the number of amendments to any given permit to ensure the Permits Division has adequate time to evaluate new requests and review reports of effects and effectiveness of permits. During scoping and public comment for the PEIS, NMFS received substantive comments expressing concerns about the numbers of amendments being requested and processed for previous permits for research on Steller sea lions. Commenters were concerned that the volume and timing of such amendments inhibited or precluded NMFS ability to adequately evaluate the cumulative impacts of research and to determine whether the research remained bona fide and humane.

Commenters were also concerned about the lack of public notice and opportunity for public input regarding NMFS's decisions about whether new or different methods were consistent with applicable statutory and regulatory permit issuance criteria. This refers to issuance of minor amendments, for which NMFS's regulations do not require public comment. Therefore, NMFS will also use a more restrictive application of the definition of major versus minor amendment, in conjunction with providing public notice of minor amendments, to enhance transparency and contribute to instilling confidence and trust in the process.

To address concerns about amendments, NMFS will:

- Not process requests for major amendments during first and last years of a permit.
- Not process requests for more than two major amendments over the life of a permit.
- Not process requests from permit holders to extend permits beyond original expiration date except in cases where additional time (less than one year) is needed to complete a discrete project. Applications for extensions must be received at least six months before the permit expires. NMFS will not process applications for extensions when the reason for the request is to allow additional time to prepare an application for a new permit.
- Determine whether an amendment is major or minor using the definitions in this document.

NMFS will not limit the number of personnel changes, photography authorizations, or minor amendments that may be requested. However, the number of such requests must be within reason. Excessive requests for minor amendments by individual permit holders may be interpreted as an inability to adequately design and appropriately plan for bona fide research.

These limits on processing amendment requests do not affect NMFS's ability to amend permits independently of a request from the permit holder. NMFS reserves the right to modify permits:

- in any case in which a violation of the terms and conditions of the permit is found
- consistent with the provisions of subpart D [Permit Sanctions and Denials] of 15 CFR part 904
- as necessary to make the permit consistent with any change made after the date of permit issuance with respect to any applicable regulation prescribed under section 103 of the MMPA and section 4 of the ESA
- if the authorized activities will operate to the disadvantage of threatened or endangered species or are otherwise no longer consistent with the purposes and policy in Section 2 of the ESA.

The following definitions of major and minor amendments will apply to applications to amend permits for research on Steller sea lions and northern fur seals:

By regulation, a **major amendment** means any change to the permit specific conditions or information provided in the application for the original permit regarding the

- number of marine mammals affected;
- species or stocks of marine mammals affected;
- locations of the research;
- period during which the permit is valid; and
- manner in which marine mammals may be taken, imported, exported or otherwise affected.

The plain language of the regulatory definition of a major amendment (see 50 CFR Part 216.39(a)(1)(ii)) implies that a change in the manner of take may be a minor amendment if the change will not result in an increased level of take or risk of adverse effect. For the purposes of this policy changes to methods of survey, capture, restraint, sampling, marking, and instrument attachment, will be considered major amendments.

By regulation, a **minor amendment** means any amendment that does not constitute a major amendment. For the purposes of this document, minor amendments include, but are not necessarily limited to, changes in objectives or hypotheses and, substituting samples already authorized for one project for use in a different *bona fide* research project.

Note that changes in personnel, such as adding co-investigators or changing the principal investigator, are not considered amendments, nor are authorizations for “non-essential personnel” (a.k.a. “photo-authorizations”). By regulation, approval for photography, filming, or audio recording activities not essential to achieving the objectives of the permitted activities, including allowing personnel not essential to the research (a documentary film crew) to be present, may be granted provided such activities do not influence the conduct of permitted activities in any way or result in takes of marine mammals. (50 CFR 216.41(c)(vii)).

Although not required by regulation, NMFS will publish a notice of issuance of any minor amendment in the *Federal Register*. Regulations currently require such notice only for issuance of original permits and major amendments. Extending this notification to minor amendments is a way to keep the public informed about changes NMFS makes to research permits. NMFS will publish such notice annually, at the end of each calendar year.

3.3 Coordination

NMFS received comments on two types of coordination: (1) coordination among researchers and (2) coordination between the research permits and grants programs. The goal of coordination among researchers is to ensure adverse effects are minimized and data collection is optimized. The goal of coordination between the research permits and grants programs is to ensure NMFS is consistent in its decisions about which research projects to permit or fund, and in enforcement of compliance with grants and permits.

Coordination among researchers. Permits will contain conditions to promote coordination among researchers. Implementation will be in cooperation with NMFS Regional Office staff. The permit conditions will establish dates and procedures for researchers to notify NMFS of planned field work. The Steller Sea Lion Coordinator, or other appropriate regional protected resources staff, will review the notifications and, if necessary, re-direct research efforts.

To minimize adverse cumulative effects, permits will require the following:

> To the maximum extent practical, the Permit Holder must coordinate permitted activities with research of other Permit Holders conducting the same or similar activities on the same species, in the same locations, or at the same times of year to avoid unnecessary disturbance of animals. The appropriate Regional Office may be contacted at the address listed above for information about coordinating with other Permit Holders.
>
> The Permit Holder must provide written notification of planned field work to the Steller Sea Lion Coordinator*. Such notification must be made annually and confirmed at least two weeks prior to initiation of any field trip/season. The notification must include the locations of the intended field study, survey routes, estimated dates of research, and number and roles of participants.

> * For research on northern fur seals, researchers will be required to provide this notification to an Assistant Regional Administrator for Protected Resources in the corresponding NMFS Region.

Upon completion of a research implementation plan by the NMFS Alaska Regional Office, NMFS may modify permits to include additional conditions for coordination, including standardized sampling protocols to optimize data collection.

Coordination between permits and grants programs. Chapter 5 of the Final PEIS indicated NMFS would review the grant and permit processes to determine whether more formalized coordination is appropriate. NMFS will take the following steps to ensure funded activities are not inconsistent with permit limitations.

- Permits Division will, at the request of the Grants Office, review grant applications and inform the Grants Office whether the proposed research is
  - covered by an existing permit
  - is eligible for a permit
    - ♦ Permits Division may need to make a provisional assessment of a grant application with respect to permit issuance criteria when grant applications do not contain the type or level of information needed to make permit eligibility determinations.
- Permits Division will provide permit applications to the Grants Office for review and comment.
  - Applications for new permits and major amendments will be provided before or during the requisite 30-day public comment period for applications.
  - Applications for minor amendments, which do not require a public comment period, will be provided once the Permits Division has established that the application is complete.
- Permits Division will share reporting information with the Grants Office.
- Permits Division will provide Grants Office with copies of approved permits to be added to the official grants file

3.4 Reports

In Chapter 5 of the PEIS, NMFS identified several issues related to permit reporting. These issues fall into four general categories: (1) compliance with permit reporting requirements, (2) coordinating or linking the permit and grant report requirements, (3) consequences for non-compliance with reporting requirements, and (4) utility of information in permit reports. This section begins with a discussion of the requirements for permit reports.

<u>Requirements for annual, final, and special reports</u>

The permit report requirements come from statutory and regulatory requirements, and are implemented as terms and conditions of permits. The MMPA requires that people authorized to take a marine mammal for scientific research furnish to NMFS a report on activities carried out pursuant to the permit (16 U.S.C. 1374 Section 104(c)(1)). The MMPA does not specify the period, format, or content of such reports; but the permits do. NMFS regulations implementing the permit provisions of the MMPA require permit holders to submit annual, final, and special reports in accordance with the terms of the permit, and the reporting format established by NMFS (50 CFR Part 216.38).

Annual reports. Permits issued by NMFS for research on marine mammals require permit holders to submit annual written reports, in both narrative and tabular format, within 90 days of the anniversary of permit issuance, unless a different due date has been agreed upon and specified in the permit. The permit outlines the format for these reports, which are primarily used to evaluate compliance with the limitations of the permit. Each year the permit is valid, permit holders must submit a tabular accounting of the number of marine mammals – by species, stock, age, sex, and location – that were taken in the past year and the manner of taking. The narrative portion of the report requires permit holders to address a series of questions about the conduct of the research, observed effects of the research, and the effectiveness of the research in achieving the research goals and objectives. A copy of the report format currently in use by NMFS for research permits is attached as Appendix E.

Final reports. Permits issued by NMFS for research on marine mammals also require permit holders to submit a final written report within 180 days of expiration of the permit. The format for this report is the same as for annual reports, except the tabular accounting of takes must be cumulative over the life of the permit.

Special reports. Permits issued by NMFS for research on marine mammals further require permit holders to submit a written "incident" (i.e., special) reports related to serious injury and mortality events or to exceeding authorized takes, within two weeks of the incident. The incident report must include a complete description of the events and identification of steps that will be taken to reduce the potential for additional research-related mortality or exceedence of authorized take. In addition to this written report requirement, the permits require the permit holder to suspend all permitted activities in the event of serious injury or mortality, or if authorized take is exceeded, and notify the Permits Division by phone within two business days of the event.

<u>Compliance with permit reporting requirements</u>

Permits Division Staff review reports to evaluate permit compliance. Permit report compliance has two meanings. First, it means permit holders submit reports by the dates and in the manner specified in the permit. Second, it means the information in the report demonstrates "take" compliance, meaning the research was within the limitations specified in the permit regarding species, locations, methods, numbers of animals, etc. NMFS permit analysts will review reports within two weeks of receipt.

Permit analysts will use an online application and report system (Authorizations and Permits for Protected Species, APPS) to track report status. Reports will be considered

- late, when not received by the date specified in the permit
- submitted, when the permit holder enters a report online or NMFS receives a paper copy

- approved, when NMFS finds it contains all required information and demonstrates takes are within limitations of permit (no evidence of non-compliance)
- unacceptable, when NMFS finds it lacks information or shows evidence of non-compliance

When NMFS finds a report unacceptable for missing information, the permit holder will be given 30 days to provide the information. When the report indicates non-compliance with take provisions, NMFS will take action as indicated under "consequences for non-compliance with reporting requirements."

Consequences for non-compliance with reporting requirements

Permits issued pursuant to this policy and guidance document will contain all of the standard permit report requirements described above. By statute (16 U.S.C. 1374 Section 104(e)), regulation (50 CFR Part 216.40), and as a condition of the permits, research permits may be modified, suspended, or revoked in any case in which a violation of the terms and conditions of the permit is found.

Delinquent or incomplete reports. Failure to submit reports by the dates specified in the permit and failure to provide adequate responses to the information requirements of the report will constitute evidence of non-compliance (i.e., a permit violation). Permits issued in accordance with this document will contain a condition that stipulates permits will be temporarily suspended, pending receipt of the applicable annual, final, or special reports, if any requisite reports are past due or otherwise fail to meet the report requirements specified in the permit. NMFS will give permit holders written notice when it finds evidence of failure to comply with terms and conditions of a permit. The notification will advise the permit holder that use of the permit is suspended pending NMFS receipt and written acknowledgement of the complete report. The notification will also advise the permit holder that the permit may be revoked if the reports are not received within 30 days.

Evidence of take non-compliance. If NMFS's review of a permit report suggests terms or conditions of the permit may have been violated (e.g., take was exceeded, mitigation measures were not followed), the permit holder will receive written notification of the suspected violation. The notification will inform the permit holder that the permit is suspended pending resolution. The permit holder will be given a 30 days to demonstrate that NMFS's finding of violation/non-compliance was in error (e.g., take not exceeded, mitigation measures were followed). If the permit holder fails to demonstrate or establish their compliance within the allowed time, NMFS will initiate steps to revoke the permit, as outlined in Section 104 of the MMPA (Part (e) regarding modification, suspension, and revocation). NMFS may also initiate steps to assess civil penalties pursuant to Section 105 of the MMPA.

Utility of information in permit reports

The information in permit and grant reports may be useful to the research community at large and promote further coordination among researchers. In Chapter 5 of the Final PEIS NMFS indicated it would investigate establishing a page on the internet where annual permit reports, technical memoranda, journal publications, and conference presentations related to Steller sea lion and northern fur seal research could be made available to all interested parties. While such a page may be useful to researchers, is not within the scope of the permit program to maintain such a site.

By regulation (50 CFR Part 216.41(c)(ii)) and permit condition, making research results available to the “scientific community” is the responsibility of the permit holder. APPS will eventually facilitate broad access to permit reports because permit holders will be submitting reports online, and can attach publications, etc. The online system is not yet set up to allow general access to permit reports, but this capability is under development.

3.5 Research effects monitoring

In the Final PEIS, NMFS acknowledged a substantial amount of uncertainty regarding effects of permitted research and identified a need for studies directed at evaluating effects of various research methods. NMFS is considering ways to encourage researchers to conduct such studies, but cannot require them in a permit. The permits do require researchers to monitor the effects of their research, but not in any systematic way.

The permits issued in 2007 contained a standard condition to conduct post-research activity monitoring to assess potential effects of research activities. In the Final PEIS, NMFS indicated that the results of this monitoring would be assessed to determine what additional conditions might need to be implemented for mitigation, and what subsequent research actions at rookeries and haulouts should be permitted.

NMFS is considering supporting studies directed at identifying effects of research through a request for proposals process. The Permits Division will evaluate the need for additional permit conditions for mitigation as new information on the effects of research becomes available.

In Chapter 5 of the Final PEIS, NMFS stated that it would circulate for public comment proposed new permit conditions associated with research actions at rookeries and haulouts. When the Permits Division identifies such conditions during application review, we will include them in the *Federal Register* notice that announces receipt of a permit application and our initial NEPA determination for that proposed permit.

3.6 Program effectiveness monitoring

A final item identified for follow-up in Chapter 5 of the Final PEIS was documenting how NMFS will evaluate whether or how well research it has permitted and funded contributes to the purpose and need established in Chapter 1 of the Final PEIS. This is also known as NEPA compliance. NEPA compliance also includes modifying an action if NMFS determines it does not contribute or is having environmental impacts beyond those evaluated in the PEIS.

It can be difficult to establish direct links between the results of a specific research activity (aerial surveys, flipper tagging, tissue biopsy) or project (foraging study) and an action NMFS can take to effect recovery. This is especially true in the short-term because some research projects require multiple years of sampling or data collection to address the hypothesis.

However, before a permit is issued, the status of the species, the Recovery Plan goals, and the risks and merits of the research are considered in determining that the research has some likelihood of contributing to recovery. Using the decision framework in Section 3.1 will improve consistency in this process and provide additional documentation for the decision. NMFS will review permit reports, permit holder publications, and other relevant information annually to evaluate the effects and contributions to recovery of the research.

If NMFS determines that a line of study, research method, etc. is not effective, or is having a greater than anticipated adverse impact, the permit will be modified. Permit modification may involve additional mitigation measures to minimize or avoid adverse impacts. It may also include revoking permission for a given activity or reducing the extent of the research (number of animals, location, timing, etc.).

4.0 Literature Cited

NMFS 2007. Steller Sea Lion and Northern Fur Seal Research Final Programmatic Environmental Impact Statement.

Appendix A. Terms of Reference for Steller Sea Lion and Northern Fur Seal Research Independent Review Panel, June 2008

Terms of Reference for Steller Sea Lion and Northern Fur Seal Research Independent Review Panel
June 2008

I. Background

Steller sea lions

Steller sea lions (*Eumetopias jubatus*) have been protected under the Marine Mammal Protection Act (MMPA; 16 U.S.C 1361 *et seq.*) since its enactment in 1972. They have also been protected under the Endangered Species Act (ESA; 16 U.S.C. 1531 *et seq*.) since being listed as threatened[1] throughout their range in 1990. In 1997, Steller sea lions were classified as two distinct population segments under the ESA. The segment of the population west of 144^{o}W longitude was listed as endangered[2], while the threatened listing was maintained for the remainder of the population in the United States.[3] The reclassification was primarily due to information that indicated two genetically differentiated population segments, a continued decline in abundance trends, and population viability analysis models that predicted a 65-100% probability of extinction for the population from Kenai Peninsula to Kiska Island within 100 years if the trends continued.

In 2000-2001, Congress appropriated approximately $80 million with direction to perform research into the causes of the decline of Steller sea lions and **to develop conservation and protective measures** to ensure sea lion recovery.[4] In addition to funds provided to the State of Alaska, the Alaska SeaLife Center, the University of Alaska, the North Pacific Marine Mammal Consortium, and various agencies within the Department of Commerce, funds were appropriated to the Secretary of Commerce to "develop and implement a **coordinated, comprehensive research and recovery program** for the Steller sea lion." These funds were allocated through a competitive grants program called the Steller Sea Lion Research Initiative (SSLRI). This Congressional funding resulted in a substantial increase in the number of applications for permits to conduct research on Steller sea lions.

During the public review of the research permit applications, the National Marine Fisheries Service (NMFS) received comments from the Marine Mammal Commission, the Humane Society of the United States (HSUS) and others expressing concerns about the magnitude of the research and the potential for adverse impacts on the species. NMFS prepared an environmental assessment[5] in June 2002 to evaluate the potential environmental impacts of issuance of permits associated with the SSLRI and $80 million in Congressional funding. NMFS determined that issuance of the permits was not likely to result in significant adverse impacts if they were limited to a term of two years and provided certain mitigation and monitoring measures were follwed.

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[1] The term "threatened species" means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
[2] The term "endangered species" means any species which is in danger of extinction throughout all or a significant portion of its range.
[3] 62 FR 24345, May 5, 1997
[4] See the notice of availability of funds for the Steller Sea Lion Research Initiative, 66 FR 15842, March 21, 2001; see also FY2001 Consolidated Appropriations Act, Pub. L. No. 106-554, Div. A, Chap. 2, Sections 206 and 209, 114 Stat. 2763, 2763A-175 through 2763A-179 (2000).
[5] Prepared to comply with the National Environmental Policy Act (NEPA; 42 U.S.C. 4321 et seq.).

As additional mitigation for potentially significant adverse impacts of permitted research, NMFS committed to development of a research coordination and monitoring plan to both ensure that future permitted research did not result in significantly adverse impacts, and to collect information on the effects of research for improving future environmental reviews.

In May 2005, NMFS prepared a new environmental assessment and extended or re-issued permits issued in 2002. In September 2005, the HSUS filed suit, alleging that NMFS authorized activities that could have a significant, irreversible impact on the ability of Steller sea lions to survive. The HSUS also alleged that, because of this potential for significant adverse impacts, NMFS should have prepared an Environmental Impact Statement (EIS) rather than an environmental assessment. The HSUS further requested that NMFS be required to conduct a workshop to: identify the key recovery plan goals that require additional research; establish an appropriate sampling design for survey, behavioral, and physiological research; develop a strategic plan and study design to ensure a cohesive approach to research; and develop quantitative models of energetics, life history, and population dynamics of Steller sea lions.

NMFS notes that some of these issues for the workshop proposed by the HSUS are beyond the scope of the permit program. NMFS issues permits in response to applications, and does not assign research projects or methods to permit holders. Rather, the permit program evaluates whether a particular application satisfies the issuance requirements of applicable laws. Nevertheless, the permit program's review of applications would benefit from independent identification of appropriate sampling designs and methodologies.

In May 2005, the court found that NMFS should have prepared an EIS rather than an environmental assessment, vacated the permits, and ordered NMFS to prepare an EIS before issuing new permits. NMFS had already begun preparation of an EIS, but the court's order effectively accelerated the timeline for completion because no research requiring a permit could be conducted until completion.

The purpose of conducting research on threatened and endangered Steller sea lions is to promote the recovery of the species' populations such that the protections of the Endangered Species Act (ESA; 16 U.S.C. 1531 et seq.) are no longer needed. Consistent with the purpose of the Marine Mammal Protection Act (MMPA; 16 U.S.C. 1361 et seq.), the purpose of conducting research on Steller sea lions is to contribute to the basic knowledge of marine mammal biology or ecology and to identify, evaluate, or resolve conservation problems for the species.

Research on Steller sea lions considered in the EIS initiated in 2005 is funded and permitted by NMFS. The need for these federal grants and permits is to facilitate research, the results of which can be used by NMFS to make management decisions that promote recovery of the species. Thus, consistent with permit issuance criteria for research on threatened and endangered marine mammals, research activities funded and permitted should directly benefit the species; contribute significantly to fulfilling a critically important research need identified by NMFS (e.g., in the species conservation or recovery plan); identify, evaluate or resolve a specific conservation problem for the subject species; or contribute significantly to the general understanding of the subject species' biology or ecology.

Northern fur seals

Research on northern fur seals (*Callorhinus ursinus*) was considered in the EIS, in addition to that on Steller sea lions, for a number of reasons relating to similarities or parallels between the species' population trends or research programs. Research on northern fur seals has not received funding at levels approaching those of the SSLRI in 2000-2001. However, there has been a three-fold increase in the number of applications for permits to conduct research on northern fur seals, largely related to similarities between the decline of the northern fur seal population in Alaska and that of the western population of Steller sea lions. In anticipation of further increases in the number of permit applications for research on northern fur seals, NMFS included this species in the EIS. NMFS recognizes two stocks of northern fur seal under the MMPA: the San Miguel Island Stock and the Eastern Pacific Stock. The Eastern Pacific Stock of northern fur seals is listed as "depleted" under the MMPA, meaning NMFS has determined this population to be below its optimum sustainable population[6]. Consistent with the MMPA, the purpose of conducting research on northern fur seals and the need for federal grants and permits to facilitate the research is the same as for Steller sea lions: to contribute to the basic knowledge of marine mammal biology or ecology and to identify, evaluate, or resolve conservation problems for these depleted species.

Programmtic EIS

NMFS completed a Programmatic EIS for the Steller sea lion and northern fur seal research programs and issued its Record of Decision in June 2007. Permits were issued for research, but limited to just over two years' duration. In the Record of Decision, NMFS stated its intent to engage in a program review, to include convening an independent panel to assess the effectiveness of the research program. NMFS determined that the research permit program would benefit from a clearly articulated decision framework that promotes a reasoned way to balance competing interests and risks to ensure that research activities authorized under the program would not permit an exemption to the protective restrictions imposed by the MMPA and the ESA for a particular study or investigation except when a particular study or investigation would be expected to promote the conservation and recovery of the species.

Upon completion of the independent review, NMFS will develop and adopt policy and guidance to improve the implementation of the Steller sea lion and northern fur seal research permit program. Until such policy and guidance is adopted, NMFS will not process any requests for amendments to the current research permits, nor will it issue new permits for Steller sea lion and northern fur seal research.

The focus of the independent panel is to recommend specific research activities or methods that should be permitted for the purpose of furthering conservation and recovery of Steller sea lions and northern fur seals. In addition to research methods, the panel will be asked to recommend appropriate mitigation measures to minimize or avoid adverse effects of permitted research, appropriate protocols to monitor or evaluate the effects of permitted research, and mechanisms to ensure appropriate coordination of permitted activities. NMFS will use the recommendations of

[6] The MMPA defines "optimum sustainable population" for a marine mammal stock as the number of animals that will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element.

the panel to develop policy and guidance to improve the implementation of the Steller sea lion and northern fur seal research permit program.

II. Goals of the Review

The primary goal of convening the panel is to seek the recommendations of independent experts on issues pertinent to NMFS' implementation of the permit program for research on Steller sea lions and northern fur seals.

NMFS seeks the views and recommendations of the panel members on four overarching areas related to implementation of the research permit program: type of research activity or project, research techniques or protocols, coordination among permit holders, and monitoring permitted research. Panelists will be asked to respond to the following questions related to these aspects of the permitted research:

1. Types of research activities or projects permitted.
   a. What specific research activities or projects (e.g., investigations of maternal investment, captive breeding and associated studies, studies of juveniles versus adults) currently or previously permitted are needed to address the conservation, management, and population monitoring needs identified in the Steller Sea Lion Recovery and Northern Fur Seal Conservation Plans?

2. Types of research methods or protocols permitted, including appropriate mitigation measures
   a. What are the most appropriate methods (e.g., survey protocols, or manner of animal captures) to conduct the research activities or projects identified as necessary to address the conservation, management, and population monitoring needs identified in the Steller Sea Lion Recovery and Northern Fur Seal Conservation Plans?
      i. When (for what studies) are permanent marks required and when would temporary marks suffice?
      ii. When is it appropriate to conduct multiple studies on the same animal versus using different animals for different studies?
      iii. When should studies be conducted using surrogate species (other marine mammal species, other vertebrate species, etc.) rather than ESA-listed, depleted, or otherwise protected species?
      iv. When should studies be conducted without living animals (e.g., using tissue culture or computer models) rather than using captive or free-ranging animals?
   b. How much (frequency, sample sizes, etc.) of a specific research activity (e.g., aerial survey, tagging, biopsy sampling, etc.) is minimally required for management and conservation needs, including population monitoring?
   c. Should there be different standards or more restrictions placed on research conducted on certain age, sex, or life-history stages or on the geographic or temporal distribution of research effort? If so, what should those limitations be?
   d. What criteria should be used for developing and incorporating new (and thus not previously evaluated) research techniques under research permits?

3. Coordination of permitted research.
    a. Assuming permits are issued to multiple individuals, what are the most appropriate mechanisms for ensuring research is not unnecessarily duplicative, and is coordinated to optimize data collection across permits and reduce adverse impacts?
        i. Alternatively, should NMFS consider limiting the number of permits as a way of ensuring coordination and cooperation among researchers and across projects?
    b. Should researchers operating under different permits (but studying the same or related questions such as aerial survey for population census or biopsy for population genetics) be required to use the same or similar methods to ensure the information collected is comparable (and to increase the sample sizes overall for a given conservation or management objective) and useful for NMFS conservation of the species?
        i. If not, how should NMFS compare or use the data from various permit holders in its management decisions and conservation efforts?

4. Monitoring effects and effectiveness of permitted research.
    a. What types of information or data are needed or should be collected to evaluate effects of permitted research?
        i. Should NMFS look to studies outside the marine mammal field for some of this information?
    b. How should permitted research be evaluated to determine whether or how it contributes to species' recovery?
        i. What types of information or data are needed or should be collected to evaluate how well permitted research is contributing to conservation and management needs for the species?
    c. Who should monitor the various research projects and methods to best assess possible effects?
    d. Should permit applications be required to provide monitoring protocols to evaluate the potential effects of the proposed research, or justify why such monitoring is not required, prior to the issuance of the permit?
    e. In the PEIS, research activities were grouped by predicted risk of mortality as estimated based on previous experience of some permit holders (See Chap 4, Mortality Assessment Tables 4.8-1 through 4.8-5). Research activities after capture were grouped from "no risk" (e.g., collecting milk samples, hair, and swabs) or low risk (e.g., collecting blood, attaching flipper tags, enemas and stomach intubation) to medium risk (e.g., biopsy sampling, pulling teeth) and high risk (i.e., surgical procedures). Hot brands were considered in a class of their own, as were procedures that do not involve capture or tissue sampling. NMFS also considered, but did not include in the PEIS, grouping these activities based on the likely nature or extent of the injury, including if something went wrong during the procedure. For example, ultrasound and other procedures that do not require cutting or puncturing the skin or inserting instruments into the body are not likely to cause injury even if done incorrectly and would therefore be considered "non-invasive" and not likely to cause long-term adverse effects or mortality. Whereas procedures that penetrate the skin, like flipper tag attachment and blubber biopsies, may only

cause minor injury but have the potential for infection and would be considered "minimally invasive" with a risk of indirect mortality or other long-term adverse effects. "Major invasive" procedures would be those like muscle biopsies, sub-cutaneous transmitters, or hot brands that result in deep tissue or more extensive injury or have greater risks of excessive bleeding or infection, and thus have a greater potential for long-term adverse effects. Finally, surgical procedures that exposed the body cavity would be a separate category.

i. Should research activities (surveys, pup-counts, rookery activities prior to capture) and procedures (activities post capture) be grouped for evaluation of effects?
ii. If so, what is the most appropriate scheme (one of the two above, or something else) for classifying or grouping research procedures for purposes of evaluating impacts or research?

III. Roles, Responsibilities, and Logistics

The Independent Panel consists of up to 6 members from outside NMFS, with expertise and knowledge relevant to the objective of the task. In general, the role of the panel will be to review past and currently permitted research on Steller sea lions and northern fur seals and, in consideration of conservation and management needs for these species, and criticisms of the permitted research, make recommendations on the following areas related to implementation of the research permit program for these species:

- what research activities (i.e., specific projects, studies, etc.) are most likely to address outstanding management and conservation needs for the species (as identified in current recovery and conservation plans);
- what research techniques (e.g., methods of survey, capture, and sampling) are most appropriate to achieve the study objectives or otherwise satisfy information needs for conservation and management of the species;
- what actions are needed for a long-term strategy to coordinate permitted research and minimize its effects at research sites; and
- what studies are needed to monitor and evaluate the effects of permitted research on the subject species, and the effectiveness of permitted research at promoting conservation and recovery of the species.

NMFS role will be to provide financial and logistic support for the work of the panel, supply background information relevant to the panel's work, and ultimately, to develop policy and guidance for improving implementation of the Steller sea lion and northern fur seal research permit program, based in part on the recommendations of the independent panel. NMFS seeks to develop measures that will improve efficiency and avoid unnecessary redundancy in Steller sea lion and northern fur seal permitted research, use best management practices, facilitate adaptive management, and standardize research protocols as appropriate.

NMFS has contracted URS to facilitate and assist with the independent panel project. URS's role includes arranging meeting logistics, panelists' travel arrangements, recording notes of panel meeting, assembly of panelists' recommendations and edits into draft and final reports, and technical editing of the final report.

Travel, lodging, and expenses for panelists will be the responsibility of NMFS, but provided through URS. URS will contact the panel members directly with details about these issues.

Applicable background material will be provided to the panelists in advance of the first ("kick-off") conference call. NMFS will provide, as background information for the panelists, copies of the following documents:

- Notice of Intent to prepare the programmatic EIS (70 FR 76780; December 28, 2005)
- Final Steller Sea Lion and Northern Fur Seal Research Programmatic Environmental Impact Statement, May 2007
    - See especially, Appendix A: Description of Active Permits; Appendix B: Description of Research Methodologies; and Appendix C: Comments Received (on NEPA documents and application)
- Record of Decision for Final Steller Sea Lion and Northern Fur Seal Research Programmatic Environmental Impact Statement, June 2007
- Biological Opinion on 2007 PEIS, June 2007
- Revised Recovery Plan for Steller Sea Lions, March 2008
- Northern fur seal conservation plan, December 2007
- MMPA and ESA permit criteria and NMFS implementing regulations
- Summary of research permitted in 2007
- Standard permit terms and conditions for mitigation, coordination, and monitoring of research on Steller sea lions and northern fur seals
- Any other documents NMFS has electronically can also be provided upon request

NMFS would also establish a virtual meeting space where panel members could access and share information over the internet. The NMFS Points of Contact will be available to assist URS and the panelists as needed, including responding to questions about the research permit program.

Panelists will be asked to:

1. Review material on own time and develop responses to specific questions by established deadlines
2. As needed, ask questions of permitted researchers via email and phone calls, facilitated by URS and NMFS as needed
3. Confer with other panelists as needed via e-conference site (to be established and maintained by NMFS)
4. Confer with other panelists via scheduled conference calls facilitated by URS: one initial kick-off call with NMFS and URS regarding terms of reference + 2 or more additional calls before final meeting (dates and times of calls to be announced)
5. Meet once with NMFS and other panelists to review draft final report and make final recommendations and edits. The final meeting will be held over a 3-day period at a venue to be determined. This meeting will be open to the public, with limited space available, but will not include public comment sessions. Only panel members will present or participate in discussions. This is not a consensus building exercise. The meeting will be facilitated by URS.

V. Panel Outcomes

Report containing recommendations and summarizing discussions of the panel on the questions posed by NMFS regarding implementation of the research permit program for Steller sea lions and northern fur seals.

VI. Project Participants

Name	Affiliation	Email	Role
Daryl Boness		Boness@megalink.net	Panelist
Don Bowen	Dept. of Fisheries and Oceans, Canada	BowenD@mar.dfo-mpo.gc.ca	Panelist
Dan Goodman	Montana State University	goodman@rapid.msu.montana.edu	Panelist
Lloyd Lowry		llowry@hawaii.rr.com	Panelist
Andrew Read	Duke University Marine Laboratory	ARead@duke.edu	Panelist
Michael Payne	NMFS	Michael.Payne@noaa.gov	NMFS Project manager
Tammy Adams	NMFS	Tammy.Adams@noaa.gov	Point of Contact
Kate Swails	NMFS	Kate.Swails@noaa.gov	Point of Contact
Jon Isaacs	URS	Jon_Isaacs@urscorp.com	URS Project Manager
Anne Southam	URS	Anne_Southam@URSCorp.com	URS Deputy Project Manager

VII. Additional information available on the internet

- Home page for Steller sea lion and northern fur seal research PEIS
  http://www.nmfs.noaa.gov/pr/permits/eis/steller.htm
- Recovery Plan for the Steller sea lion
  http://www.nmfs.noaa.gov/pr/pdfs/recovery/stellersealion.pdf
- NMFS home page for Northern fur seals
  http://www.fakr.noaa.gov/protectedresources/seals/fur.htm
- NMFS Protected Resources home page for Steller sea lions
  http://www.nmfs.noaa.gov/pr/species/mammals/pinnipeds/stellersealion.htm
- NMFS marine mammal stock assessment reports
  http://www.nmfs.noaa.gov/pr/sars/
- NMFS Scientific Research and Enhancement Permit Application Instructions
  http://www.nmfs.noaa.gov/pr/permits/mmpa_permits.htm#enhancement

Appendix B. Report of the Independent Review Panel on the National Marine Fisheries Service's Implementation of the Permit Program for Research: Steller Sea Lion and Northern Fur Seal Case Study

Report of the Independent Review Panel on the National Marine Fisheries Service's Implementation of the Permit Program for Research: Steller Sea Lion and Northern Fur Seal Case Study

Panel members:

Don Bowen, Bedford Institute of Oceanography, Dartmouth, NS, Canada
Laurie Gage, USDA, Animal and Plant Health Inspection Service, Animal Care
Dan Goodman, Montana State University, Bozeman, MT
Lloyd Lowry, University of Alaska, Fairbanks, AK

14 October 2008

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LIST OF ACRONYMS

AWA	Animal Welfare Act
DNA	deoxyribonucleic acid
ESA	Endangered Species Act
F/PR1	NMFS Office of Protected Resources, Permits, Conservation and Education Division
HMS	Hawaiian monk seal
HMSRT	Hawaiian Monk Seal Recovery Team
IACUC	Institutional Animal Care and Use Committee
MMPA	Marine Mammal Protection Act
NFS	northern fur seal
NMFS	National Marine Fisheries Service
PEIS	Programmatic Environmental Impact Statement
PIRO	Pacific Islands Regional Office
RPEP	research permit evaluation process
SSL	Steller sea lion
SSLRT	Steller Sea Lion Recovery Team
TDR	time-depth recorder
VHF	very high frequency

EXECUTIVE SUMMARY

The National Marine Fisheries Service (NMFS) Office of Protected Resources, Permits, Conservation and Education Division (F/PR1) convened an expert panel to provide advice on the process it uses to issue permits to do scientific research on marine mammals, particularly as applied to Endangered Species Act (ESA)-listed species such as Steller sea lions (SSL) but also for northern fur seals (NFS) which are protected under the Marine Mammal Protection Act (MMPA). F/PR1 provided the panel with a list of questions and asked for responses to those questions. The panel reviewed a number of documents concerning the permit process and the permits that had been issued, and developed responses to those questions based on their review. They later met for three days to discuss how best to evaluate permit requests and to develop recommendations.

It is the view of the panel that there are three questions that the NMFS F/PR1 must address prior to issuing a permit to work on a marine mammal species listed under the ESA:

1. Is the proposed research sound and has it been vetted through scientific peer review?
2. Will findings from the proposed research likely be useful for promoting recovery, again as determined through scientific peer review with reference to the available recovery plan and any updated information?
3. Are the procedures being proposed humane and do they represent best animal care and husbandry practice as evaluated by an Institutional Animal Care and Use Committee (IACUC)?

Ideally, recovery plans and recovery teams could play a larger role in this process than they do at present. For recovery plans and recovery teams to function effectively in this role, recovery plans would need to be issued more rapidly and updated more frequently; recovery plans would need to give more attention to setting very explicit research priorities linked to resolving uncertainty about threat reduction and recovery actions; and decisions about recovery team composition would need to be sensitive to conflicts of interest with respect both to research agendas and implications for management choices. To the extent that recovery plans and recovery teams cannot fully fill this role, permitting decisions about the potential for research to contribute to recovery will need to rely on the advice of *ad hoc* panels of experts.

The panel recommends the following:

- F/PR1 should not attempt to operate the research permit evaluation process (RPEP) using only their in-house assets.
- F/PR1 should review, and modify if needed, permit reporting requirements and procedures for storing permit report data.
- F/PR1 should use existing mechanisms, or if necessary establish additional mechanisms, to enforce permit provisions and, if necessary, revoke, suspend, or modify permits.
- F/PR1 should require that researchers participate in coordination efforts as a condition of their permit, and should assign staff to facilitate and oversee the required coordination efforts.

- Proposals or study designs of projects involving research on ESA-listed marine mammals should be peer-reviewed to ensure scientific integrity prior to permit requests being submitted to F/PR1.
- To the extent possible, NMFS should rely on recovery plans and recovery teams to provide guidance on the types of research needed to support recovery programs for ESA-listed marine mammals.
- NMFS should review the current format and content of recovery plans, and make modifications to recovery plan guidance, as needed to improve their utility for use in the RPEP.
- In convening recovery teams, NMFS should attempt to maintain independence and diversity of the scientists appointed. Mechanisms should be provided to avoid conflicts of interest in identifying and prioritizing research needs. F/PR1 should participate in the recovery team/recovery plan process.
- NMFS should provide support for meta-analyses of datasets when such analyses can help identify information gaps and research needs. Two examples are monitoring and measuring research impacts and use of telemetry to study habitat use.
- NMFS should develop a system to use expert panels to provide review of science needed for the RPEP when such information is not provided by a recovery plan or recovery team.
- F/PR1 should ensure that any permitted research complies with all relevant legislation and policies (ESA, MMPA, Animal Welfare Act (AWA)).
    - Compliance with humane practices requirements could be accomplished by requiring that research procedures be pre-approved by a competent IACUC.
    - Compliance with the requirement that the research serve a recovery need should be evaluated with reference to the recovery plan, recovery team consultation, and expert panels. The evaluation itself may best be done using a risk-benefit analysis conducted by experts outside of F/PR1.

SECTION I. ANSWERS TO QUESTIONS POSED BY NMFS

1. Types of research activities or projects permitted.

    a. What specific research activities or projects (e.g., investigations of maternal investment, captive breeding and associated studies, studies of juveniles versus adults) currently or previously permitted are needed to address the conservation, management, and population monitoring needs identified in the Steller Sea Lion Recovery and Northern Fur Seal Conservation Plans?

Before dealing with the question of what specific types of research are needed to address conservation issues of these two species, it is useful to review the framework within which such research is conducted. There is obvious concern over the conservation status of both species; the eastern Pacific stock of NFS is designated as *depleted* under the MMPA and the western stock of SSL is listed as *endangered* under the ESA while the eastern SSL stock is listed as *threatened*. Attempts to gain understanding of the status of both have been greatly complicated by oceanographic regime shifts and the possible propagation of effects of fisheries through the food web. As a consequence there is still considerable uncertainty over what management actions are really needed, and this uncertainty carries over to the issuance of permits to conduct research intended to reduce management uncertainty. Thus, first and foremost, we should aim to conduct research and monitoring that is needed to identify, and decide on the appropriateness of, management actions that might be taken to promote recovery, or those needed to evaluate the effectiveness of management actions that have been taken in the past. Secondly, only research projects judged to have a low net risk of negative impacts on sea lion recovery, compared to the anticipated benefit to the population, should be carried out, though the evaluation of that risk, and benefit, may itself involve considerable uncertainty. Although these may serve as guidelines, it would be a mistake to be too prescriptive in deciding on what research to permit. This is because we usually do not know which threats, either singly or in combination, are actually limiting population size. Furthermore, some limiting factors, such as predation or environmental variation resulting in changes in food supply, may not be readily "managed", but understanding the effects of those factors is nonetheless important in evaluating cumulative effects.

Another consideration for permitting research deals with the extent to which study conclusions can be linked to the actual demography of the species in question. Designs that are adequate to establish the plausibility of the role of some factor may not be sufficient to guide an intervention. So, once plausibility has been determined, it would be redundant and inefficient to permit further research on plausibility. Then the permitting process should raise the bar and require that further research on that factor should meet a stronger standard of relevance and utility. For example, a number of behavioral and physiological studies have been conducted on both SSL and NFS with the objective of 'testing' the hypothesis that food limitation is important in their observed declines. But the behavioral and physiological responses that were found by such research have not yet been shown to have had negative impacts on the demography of these species at the population level. For another example, studies have shown that the duration of foraging trips of lactating females differs among sites and such results have been interpreted as evidence for the role of food limitation in explaining population declines. But evidence is still lacking that such behavioral differences are linked to the demography of the population. For another example, some study designs compare some features of animals from a site experiencing positive population growth with those from another exhibiting a decline. But with only a single study site each of ‘treatment’ and ‘control’ it is not generally possible to rule out confounding by coincidental site differences. Given the cost and logistical difficulty in conducting multi-site field research, one effective approach would be to encourage or require cooperation among research groups with similar interests.

This question asks the panel to evaluate “specific research activities or projects” in the context of “the conservation, management, and population monitoring needs identified in the Steller Sea Lion Recovery and Northern Fur Seal Conservation Plans.” While it would seem a reasonable thing to use the existing recovery and conservation plans as the basis for making such an evaluation, the panel sees problems with using the plans in this way.

First of all, the way in which the existing plans identify actions needed for recovery does not always correspond well with a logical organization of the science questions that need to be answered in support of those actions. For example, a single action item may require information from several research activities, and a single research activity may provide data that support several action items. To help deal with this issue, the panel proposes a set of five questions pertinent to organizing research designed to promote or monitor recovery for a species of conservation concern. There are many ways to categorize and organize such research, but the panel agreed that these questions were appropriate for the task at hand. The first questions address the status of the population and life history characteristics that underlie population dynamics. The remaining questions concern factors affecting growth, productivity, mortality, and habitat use, as shown below:

- What is the status of the population?
- What are its life history characteristics?
- What factors are affecting growth of individuals and population productivity?
- What factors are affecting mortality?
- What habitats are used for important ecological functions, and what factors are affecting those habitats?

A second problem with the existing recovery and conservation plans is that, due to the time required for development and approval of the plans, some actions identified in the plan have become outdated by the time that specific research is proposed to address them. How much this problem will impact an evaluation of current research needs depends on the frequency with which plans are updated, the rate of change in population status, and the amount of research being conducted each year. Finally, in many, if not most, cases not all available data relating to specific research questions have been compiled, analyzed, and reported at the time plans were prepared or at the time permit requests were being evaluated. Therefore it often is not possible from the existing recovery plan to fully evaluate the nature and importance of data gaps and how important the proposed research is to filling those gaps. Some potential options for dealing with these shortcomings of recovery plans are discussed in section II of this report.

Northern fur seal

For reasons discussed above, and others, the panel was uncomfortable with attempting to do a detailed, item by item, evaluation of permitted research activities versus needs identified in conservation/recovery plans. However, to see if our concerns were warranted we attempted such an analysis first for NFS, which we believed would be more tractable than SSL.

The Conservation Plan for the Eastern North Pacific Stock of Northern Fur Seal, published in December 2007, lists a number of conservation actions that require or may be supported by scientific research. We have organized those actions under our list of five research questions as shown in Appendix 1. For each of the questions, we have indicated the priority attached to each research action in the Conservation Plan.

There are currently seven active research permits that allow scientific research on NFS that may cause more than level B harassment. A description of the research objectives, location and timing of research, and specific research activities is given for each permit in Appendix 2. One of the permits addresses basic population monitoring and also involves field studies to determine factors affecting the population. Two other permits primarily cover field studies to determine factors affecting the population. One permit allows the establishment of a captive colony of adult females that will be used for a variety of physiological studies. One permit involves the quantification of marine debris that is entangling seals, and the removal of that debris. Two permits allow collection of tissues from dead animals, removal of debris from entangled seals, and observations of the environment at NFS rookeries.

To evaluate the specific research activities being permitted in the context of the conservation, management, and population monitoring needs identified in the Northern Fur Seal Conservation Plan, we have matched up those needs and activities, organized according to our five research questions. The following sections describe the panel's conclusions regarding the relationship between permitted activities and identified needs.

What is the status of the population?

The conservation plan specifies that population status will be monitored through counts of adult male seals on rookeries, estimates of pup production and survival, estimates of vital rates, and several other studies that can provide insights into status through monitoring other biological parameters (Table 1). It also recommends a reevaluation of carrying capacity, an important, but often elusive, parameter for evaluating status, and ecosystem modeling that can help to understand factors limiting carrying capacity and thus affecting status.

Table 1 lists the research activities that are currently permitted that are related to studies of population status. It is the opinion of the panel that all these activities can provide information useful to addressing information needs identified in the plan. We note that the basic assessment methods used on rookeries (*e.g.*, counts of adult males, estimates of pup production, counts of dead pups, collection and examination of teeth, measurements of animals taken in the harvest) are well proven, and over the years have resulted in a valuable long-term dataset. Marking of fur, flipper tagging, and insertion of coded wire tags all will help with individual identification of seals, a necessary element in the study of survival and other vital rates. The use of ultrasound to examine reproductive tracts of adult females caught at sea is novel, and a properly conducted study could provide needed information on pregnancy rates and other aspects of female reproductive biology that are difficult to obtain by other non-lethal methods.

What are the life history characteristics of northern fur seals?

The conservation plan includes three action items that specifically relate to life history studies (*e.g.*, analysis of teeth, marking animals, and estimating vital rates) and two that involve behavioral and physiological studies that may provide information on life history (Table 2).

The list of research activities related to studies of life history (Table 2) is nearly identical to that for population status, and, in the opinion of the panel, all can provide information useful for addressing needs identified in the plan.

What factors are affecting growth of individuals and population productivity?

Conservation plan action items relating to growth and productivity (Table 3) focus on two general areas: 1) studies to measure effects of human activities (*e.g.*, disturbance, pollutants, fisheries) on NFS; and 2) studies to help understand how natural factors (*e.g.*, disease, environmental conditions, ecosystem factors) affect NFS.

Current permits allow many specific activities that relate to gathering information relevant to questions of growth and productivity of NFS, and how those parameters may be impacted by human-caused and natural factors (Table 3). Samples of blood and blubber can be used to measure contaminant levels. Studies of diet (*e.g.*, collection of prey parts by lavage or enema and from scats) and foraging behavior (*e.g.*, satellite tagging and insertion of stomach temperature transmitters) are needed to evaluate natural and anthropogenic impacts on fur seal feeding. Body and blubber measurements; samples of blood, milk, blubber, muscle, vibrissae, hair, and nails; and measurements of isotope dilution and bioimpedence from seals on rookeries all can provide information on body condition and nutritional status. The project to establish a captive experimental colony of adult females, and its specific research activities, will provide additional insights into a variety of physiology questions, and may be particularly useful for action item 3.1.6 “Evaluate behavioral/physiological studies.” The project to capture seals at sea could provide data on growth and productivity, and directly responds to action item 2.7.2 “Evaluate pelagic fur seal sampling.”

What factors are affecting mortality?

The conservation plan includes action items relating to determining the impact of mortality factors including those caused by human activities (*e.g.*, marine debris, incidental take in fisheries, subsistence harvests, illegal harvests, pollution) and natural factors (*e.g.*, predation, disease) (Table 4).

The permitted research activities relating to mortality relate primarily involve obtaining samples to study disease and studies of impacts of debris (Table 4). It is the opinion of the panel that all these activities can provide information useful to addressing information needs identified in the plan.

What habitats are used for important ecological functions, and what factors are affecting those habitats?

Conservation plan actions relating to habitat include analysis of existing data on habitat use and the physical environment, collection of additional data particularly in the marine environment, and ecosystem modeling (Table 5).

Two permits include an activity to observe and monitor fur seal habitat use on land, and all other activities relate to research to investigate habitat use at sea (Table 5). We note that the project that would catch, sample, and attach satellite-linked transmitters with stomach transmitters to non-pups and then recapture and resample those animals could provide particularly useful information on specific aspects of how fur seals use marine habitats for feeding. Also, the project that would capture, sample, and attach satellite-linked transmitters with stomach transmitters to seals caught at sea could extend habitat use data to areas and seasons that have not previously been well sampled. It is the opinion of the panel that all these activities can provide information useful to addressing information needs identified in the plan.

Table 1. Conservation plan action items and permitted research activities relating to the question of status of the eastern North Pacific stock of northern fur seal (figures in parentheses correspond to permit numbers).

Conservation plan action items
3.1.2 Continue regular counts of adult males and estimates of pup production on St. Paul, St. George, and Bogoslof Islands
3.1.3 Estimate pup survival
3.1.5 Estimate stock vital rates
3.1.6 Evaluate behavioral/physiological studies
3.1.7 Continue comparative studies on other islands
3.1.9 Promote joint research and collaborative programs
3.4.1 Reevaluate carrying capacity
3.4.6 Ecosystem modeling
Permitted research activities
Capture and restrain pups on land (782-1708-3; 881-1893; 715-1884)
Clip fur from pups (782-1708-3)
Mark fur of pups (782-1708-3; 881-1893)
Attach flipper tags to pups (782-1708-3; 881-1893; 715-1884)
Insert coded wire tag in pups (715-1884)
Capture, restrain, and sedate non-pups on land (782-1708-3; 715-1884)
Extract tooth from non-pups (782-1708-3; 715-1884)
Mark fur of non-pups (782-1708-3)
Attach flipper tags to non-pups (782-1708-3; 715-1884)
Insert coded wire tag in adult females and subadult males (715-1884)
Capture, restrain, and sedate seals at sea (881-1893)
Attach flipper tags to seals caught at sea (881-1893)
Take ultrasonographs of female reproductive tracts of seals caught at sea (881-1893)
Census adult males by counting from a distance (782-1708-3)
Collect and examine dead pups and non-pups (782-1708-3)
Measure animals taken in subsistence harvest (715-1884)
Collect teeth and tissues from dead seals (782-1708-3; 715-1884; 1118-1881; 1119-1882)
Round up subadult male seals and count by age class (1066-1750)

Table 2. Conservation plan action items and permitted research activities relating to the question of life history characteristics of eastern North Pacific northern fur seals (figures in parentheses correspond to permit numbers).

Conservation plan action items
3.1.1 Analyze fur seal teeth
3.1.4 Evaluate marking programs
3.1.5 Estimate stock vital rates
3.1.6 Evaluate behavioral/physiological studies
3.1.7 Continue comparative studies on other islands
Permitted research activities
Capture and restrain pups on land (782-1708-3; 881-1893; 715-1884)
Clip fur from pups (782-1708-3)
Mark fur of pups (782-1708-3; 881-1893)
Attach flipper tags to pups (782-1708-3; 881-1893; 715-1884)
Inject tetracycline into pups (715-1884)
Insert coded wire tag in pups (715-1884)
Capture, restrain, and sedate non-pups on land (782-1708-3; 715-1884)
Extract tooth from non-pups (782-1708-3; 715-1884)
Mark fur of non-pups (782-1708-3)
Attach flipper tags to non-pups (782-1708-3; 715-1884)
Insert coded wire tag in adult females and subadult males (715-1884)
Capture, restrain, and sedate seals at sea (881-1893)
Attach flipper tags to seals caught at sea (881-1893)
Take ultrasonographs of female reproductive tracts of seals caught at sea (881-1893)
Census adult males by counting from a distance (782-1708-3)
Measure animals taken in subsistence harvest (715-1884)
Collect teeth and tissues from dead seals (782-1708-3; 715-1884; 1118-1881; 1119-1882)
Round up subadult male seals and count by age class (1066-1750)

Table 3. Conservation plan action items and permitted research activities relating to the question of growth and productivity in the eastern North Pacific stock of northern fur seal (figures in parentheses correspond to permit numbers).

Conservation plan action items

2.4 Conduct studies to quantify effects of human activities (*e.g.* research, hunting, tourism, vehicles, discharges, facilities) at or near breeding and resting areas
2.6.1 Compile and evaluate existing pollutant data
2.6.2 Monitor and study environmental pollutant exposure
2.7.1 Study the natural and anthropogenic influences on fur seal feeding ecology
2.7.2 Evaluate pelagic fur seal sampling
2.7.4 Determine impact of fisheries
3.1.6 Evaluate behavioral/physiological studies
3.2.1 Compile and evaluate existing disease data
3.2.2 Determine and mitigate disease effects
3.4.5 Quantify environmental effect on behavior and productivity
3.4.6 Ecosystem modeling

Permitted research activities

Capture and restrain pups on land (782-1708-3; 881-1893; 715-1884)
Weigh and measure pups (782-1708-3; 715-1884)
Take ultrasound measurements of blubber of pups (782-1708-3; 881-1893)
Take blood samples from pups (782-1708-3; 881-1893; 715-1884)
Take blubber samples from pups (881-1893; 715-1884)
Take muscle biopsies from pups (881-1893)
Take fecal loops and swabs from pups (782-1708-3; 881-1893; 715-1884)
Take vibrissae from pups (881-1893; 715-1884)
Take hair from pups (881-1893)
Take nails from pups (881-1893)
Gastric lavage pups (782-1708-3)
Attach satellite-linked tags to pups (782-1708-3; 881-1893)
Measure isotope dilution in pups (881-1893)
Measure bioelectric impedance in pups (881-1893)
Place stomach temperature transmitters in pups (881-1893)
Inject tetracycline into pups (715-1884)
Capture, restrain, and sedate non-pups on land (782-1708-3; 715-1884)
Weigh and measure non-pups (782-1708-3; 715-1884)
Extract tooth from non-pups (782-1708-3; 715-1884)
Take ultrasound measurements of blubber of non-pups (782-1708-3)
Take blood samples from non-pups (782-1708-3; 715-1884)
Take vibrissae from adult females and subadult males (715-1884)
Take blubber sample from adult females and subadult males (715-1884)
Take fecal loops from non-pups (782-1708-3; 715-1884)
Take swabs from non-pups (782-1708-3)
Collect milk samples from non-pups (782-1708-3)

Table 3, continued.

***Permitted research activities**, continued*
Attach satellite-linked tags, TDRs, VHF tags to non-pups (782-1708-3; 715-1884)
Insert stomach temperature transmitter in non-pups (782-1708-3)
Recapture non-pups (782-1708-3)
Measure and ultrasound recaptured non-pups (782-1708-3)
Collect milk and blood samples from recaptured non-pups (782-1708-3)
Collect feces by enema from recaptured non-pups (782-1708-3)
Capture, restrain, and sedate seals at sea (881-1893)
Take blood samples from seals caught at sea (881-1893)
Take blubber samples from seals caught at sea (881-1893
Take muscle biopsies from seals caught at sea (881-1893)
Take fecal loops and swabs from seals caught at sea (881-1893)
Take vibrissae from seals caught at sea (881-1893)
Take hair from seals caught at sea (881-1893)
Take nails from seals caught at sea (881-1893)
Measure isotope dilution in seals caught at sea (881-1893)
Measure bioelectric impedance in seals caught at sea (881-1893)
Take ultrasound measurements of blubber of seals caught at sea (881-1893)
Attach satellite dive recorders to seals caught at sea (881-1893)
Place stomach temperature transmitters in seals caught at sea (881-1893)
Take ultrasonographs of female reproductive tracts of seals caught at sea (881-1893)
Capture female pups and hold in facility on island (715-1883)
Remove female pups from island to captivity (715-1883)
Take blood samples and conduct oral and eye exams on rookery (715-1883)
Take blood samples at captive colony (715-1883)
Manipulate diets of captive seals including fasting (715-1883)
Take morphological measurements of captive seals (715-1883)
Take blubber biopsies of captive seals (715-1883)
Measure blubber of captive seals with ultrasound (715-1883)
Determine body condition of captive seals with isotopes (715-1883)
Measure metabolism of captive seals in metabolic chamber (715-1883)
Collect scats (782-1708-3; 715-1884)
Measure animals taken in subsistence harvest (715-1884)
Collect teeth and tissues from dead seals (782-1708-3; 715-1884; 1118-1881; 1119-1882)

Table 4. Conservation plan action items and permitted research activities relating to the question of mortality in the eastern North Pacific stock of northern fur seal (figures in parentheses correspond to permit numbers).

Conservation plan action items
1.1.1 Continue disentanglement program to reduce mortality and harm to fur seals entangled in marine debris
1.1.2 Remove marine debris and incorporate surveys of debris in northern fur seal habitat
1.1.3 Examine the fate of entangling debris
1.2.1 Implement and evaluate fishery and marine mammal observation programs in the North Pacific Ocean and Bering Sea
1.2.2 Review observer and incidental take data
1.3.1 Monitor and manage subsistence harvests
1.3.2 Develop and implement harvest sampling programs
1.3.3 Compile and evaluate existing harvest data
1.3.4 Identify and evaluate illegal harvests
2.4 Conduct studies to quantify effects of human activities (*e.g.* research, hunting, tourism, vehicles, discharges, facilities) at or near breeding and resting areas
2.6.1 Compile and evaluate existing pollutant data
2.6.2 Monitor and study environmental pollutant exposure
2.6.3 Evaluate carcass salvage programs
2.7.3 Report fishery interactions
3.1.8 Conduct appropriate studies to assess the impact of predation (*e.g.*, killer whales, Steller sea lions, sharks) on fur seal populations
3.2.1 Compile and evaluate existing disease data
3.2.2 Determine and mitigate disease effects
Permitted research activities
Collect and examine dead pups and non-pups (782-1708-3)
Capture and restrain pups on land (782-1708-3; 881-1893; 715-1884)
Take blood samples from pups (782-1708-3; 881-1893; 715-1884)
Take fecal loops and swabs from pups (782-1708-3; 881-1893; 715-1884)
Capture, restrain, and sedate non-pups on land (782-1708-3; 715-1884)
Weigh and measure non-pups (782-1708-3; 715-1884)
Take blood samples from non-pups (782-1708-3; 715-1884)
Take fecal loops and swabs from non-pups (782-1708-3; 715-1884)
Capture, restrain, and sedate seals at sea (881-1893)
Take blood samples from seals caught at sea (881-1893)
Take fecal loops and swabs from seals caught at sea (881-1893)
Collect teeth and tissues from dead seals (782-1708-3; 715-1884; 1118-1881; 1119-1882)
Round up subadult male seals and count by age class (1066-1750)
Characterize the type and weight of debris and the extent of the wound created by the debris on subadult male seals (1066-1750)
Remove entangling debris from seals (1066-1750; 1118-1881; 1119-1882)

Table 5. Conservation plan action items and permitted research activities relating to the question of habitats of the eastern North Pacific stock of northern fur seal (figures in parentheses correspond to permit numbers).

Conservation plan action items
3.3.1 Compile and evaluate available habitat-use data
3.3.2 Conduct oceanographic and fishery surveys based on pelagic fur seal habitat use
3.4.2 Continue and evaluate Pribilof Islands Sentinel Program
3.4.3 Compile and evaluate existing physical environmental data
3.4.4 Select appropriate environmental indices
3.4.6 Ecosystem modeling
Permitted research activities
Capture and restrain pups on land (782-1708-3; 881-1893; 715-1884)
Attach satellite-linked tags to pups (782-1708-3; 881-1893)
Place stomach temperature transmitters in pups (881-1893)
Capture, restrain, and sedate non-pups on land (782-1708-3; 715-1884)
Weigh and measure non-pups (782-1708-3; 715-1884)
Extract tooth from non-pups (782-1708-3; 715-1884)
Take ultrasound measurements of blubber of non-pups (782-1708-3)
Take blood samples from non-pups (782-1708-3; 715-1884)
Collect milk samples from non-pups (782-1708-3)
Attach satellite-linked tags, TDRs, VHF tags to non-pups (782-1708-3; 715-1884)
Insert stomach temperature transmitter in non-pups (782-1708-3)
Recapture non-pups (782-1708-3)
Measure and ultrasound recaptured non-pups (782-1708-3)
Collect milk and blood samples from recaptured non-pups (782-1708-3)
Collect feces by enema from recaptured non-pups (782-1708-3)
Capture, restrain, and sedate seals at sea (881-1893)
Attach satellite dive recorders to seals caught at sea (881-1893)
Place stomach temperature transmitters in seals caught at sea (881-1893)
Take ultrasonographs of female reproductive tracts of seals caught at sea (881-1893)
Monitor parameters of the fur seal environment on rookeries (1118-1881; 1119-1882)

Steller Sea Lion

The revised Recovery Plan for the Steller Sea Lion, published in March 2008, lists a large number of recovery actions that require or may be supported by scientific research. We have organized those actions under our list of five questions as shown in Appendix 3. For each of the questions, we have shown the priority attached to each research action in the Recovery Plan.

As stated earlier and shown above, the panel conducted a detailed evaluation of research activities versus Conservation Plan needs for NFS in part to determine if there was merit in conducting a similar exercise for SSL. In our opinion the exercise with NFS was tedious and time-consuming, and it did not produce any surprising or significant results. We believe that a similar analysis for SSL would produce similar results—the likely conclusion would be that all, or nearly all, specific research activities currently being permitted can justifiably be viewed as responsive to one or more of the action items called for in the Recovery Plan. For that reason, the panel did not proceed further with attempting to answer this question for SSL.

2. <u>Types of research methods or protocols permitted, including appropriate mitigation measures.</u>

   a. *What are the most appropriate methods (e.g., survey protocols, or manner of animal captures) to conduct the research activities or projects identified as necessary to address the conservation, management, and population monitoring needs identified in the Steller Sea Lion Recovery and Northern Fur Seal Conservation Plans?*

      i. *When (for what studies) are permanent marks required and when would temporary marks suffice?*

Long-lasting or permanent marks are needed for long-term studies intended to follow the behavior, growth, reproductive success and survival of individuals through time. Sighting histories of permanently marked individuals provide the only non-lethal method to obtain data on these vital parameters. Such information is often critically important to understanding the factors affecting threatened and endangered species and the conservation measures needed for their recovery. Both SSL and NFS lend themselves to long-term study (long-term studies of individuals are not feasible for some marine mammal species), and such research has contributed to our understanding of how these animals cope with a variety of threats. Permanent marking is particularly useful when it is possible to access a large sample of known-age animals without undue disturbance, injury or mortality, as is the case for SSL and NFS. For most pinniped species, including SSL and NFS, such marks are typically applied to cohorts of pups. To be the most useful, long-term marks should be able to be identified from a reasonable distance *(i.e.*, far enough away that the animal is not disturbed by the presence of the investigator). Many marine mammals (*e.g.*, harbor and grey seals and most cetaceans) can be identified through the use of natural marks, such as individually distinctive patterns of pelage, scars, or other features. The practicality of such methods depends on the distinctiveness and longevity of individual marks, the ease with which individuals may be observed or photographed, and the size of the study population. If a sufficient portion of the population is permanently marked, there may be little or no need to apply temporary marks for short-term studies. Permanent or long-term marking is an essential aspect of studies to measure the cumulative impact of research activities on study animals, because observations of behavioral changes, injuries, or deaths, are not informative for this purpose unless they can be traced to the exposure of individual animals to a specific history of disturbance, handling, and treatment.

ii. When is it appropriate to conduct multiple studies on the same animal versus using different animals for different studies?

Generally speaking, use of the same animal for multiple studies is appropriate provided that this does not disadvantage the survival of the animal or introduce bias into the resulting observations. The use of the same animals in multiple studies may, in fact, be recommended when the additional information gained from such an approach provides a deeper or more complete understanding of the research question under study. For example, studies of foraging are often more informative if the consequences of foraging performance are linked with changes in body condition or attendance behavior of females provisioning young. However, the decision to use the same animal in multiple studies needs to be made on a case-by-case basis, with consideration given to the specific nature of the studies (*i.e.*, what actually is being done to the animal and what data are to be collected) and the vulnerability of the animal being studied (*e.g.*, age, sex and reproductive status). Given the diversity of studies and procedures that might be combined, it will be difficult and perhaps counterproductive to attempt to develop specific criteria that can be generally applied. It would be more valuable, as cases arise, to seek the expert opinions of a group of veterinarians and biologists to determine whether it is appropriate to apply multiple procedures to the same animal.

Observations should be made during each procedure, followed by appropriate monitoring, to determine whether the application of multiple procedures has any adverse effects or has compromised use of that animal for a further procedure. Detailed records should be kept, including: methods of capture and handling; drugs administered; animal's response to drugs/handling; results of the physical examination; and environmental data (*e.g.*, temperature and cloud cover) that might be expected to influence the animal's condition during the procedures. These data should be made available as soon as possible to other researchers studying the same animal or working at the same study site. Such real-time information sharing could be readily facilitated using a secure web site or listserver. Whenever possible, a control group of individuals should be studied to assess the potential negative impacts of multiple procedures. In some cases, testing of the possible impact of combining certain procedures could be done on captive animals.

iii. When should studies be conducted using surrogate species (other marine mammal species, other vertebrate species, etc.) rather than ESA-listed, depleted, or otherwise protected species?

Generally speaking, questions about population growth, demographic parameters, habitat use, and resource relationships will need to be answered by directed research on the population of concern. Alternatively, if there is concern that such research might involve methods that cause significant harm to some individuals or if there is concern that the proposed research methods or study design might not be effective, it would be reasonable to first test the level of harm and the degree of effectiveness on a surrogate species. Such an approach assumes that a credible surrogate is available. A preliminary investigation of the methods and study design on a surrogate species—essentially a proof of concept—would not substitute for the eventual research on the species of concern itself. However, the results of the preliminary research on the surrogate species would increase confidence that the proposed research on the species of interest met the criteria of not posing undue risk while at the same time providing needed information.

Thus, the use of surrogate species should be considered when there is considerable uncertainty about, or high risk associated with, the impact of a study on the species of concern. The decision to use a surrogate species will depend on two factors: (1) the existence of a valid surrogate species of lower conservation concern; and (2) the conservation status of the species in question and the likelihood that injuries or deaths caused by the research might result in an unacceptable impact on recovery. The appropriateness of a surrogate species will depend upon the question being addressed. For example, development of techniques for collecting, storing, and analyzing DNA for genetics studies could be performed on samples taken from almost any mammalian species. Similarly, the development of novel medical techniques including anesthesia, instrument attachment methods, or surgical procedures to implant data-loggers or telemetry devices may be effectively conducted on surrogate species. Studies of basic physiological processes and their responses to various perturbations (*e.g.*, diseases and contaminants) are also likely to be amenable to surrogate studies, as is done commonly in studies of human biology and medicine. However, if the question has to do with species-specific attributes, such as dispersal rates or diet, then surrogate species are not appropriate. Ecological relationships with other species and behavioral responses to environmental variability are likely to be species-specific. Without careful justification, results from surrogate studies are likely to be of questionable value in answering questions relating to recovery needs of endangered species.

As mentioned above, the concern about using surrogate species should be scaled to the true conservation status of the species in question. While both are substantially reduced, populations of both SSL and NFS are presently relatively large in comparison to other marine mammal taxa within the same protective categories (Lowry *et al*. 2006). Therefore, as a general rule it would not seem necessary to require use of surrogate species for studies of SSL and NFS, although such an approach might be desirable under some special circumstances.

iv. When should studies be conducted without living animals (e.g., using tissue culture or computer models) rather than using captive or free-ranging animals?

The choice of experimentation on live animals versus a model substitute depends entirely on the relative adequacy of the two approaches to answer the question of interest with a high enough level of confidence. Substituting a model exercise or tissue culture for more direct research may involve an 'extrapolation error' in transferring the conclusion from the lab to the field, or a 'model prediction error' having to do with the many uncertainties involved in the model (*i.e.,* parameter uncertainty, initial conditions uncertainty, and uncertainty about model form). Alternatively, field research may be unable to directly answer a particular question because of the logistical difficulty or expense involved, or the existence of confounding factors. Before denying a permit for live animal research on grounds that a lab experiment or a modeling exercise should be substituted, it should be convincingly demonstrated that the proposed substitute has a high probability of delivering the needed degree of certainty. Absent this criterion, the universal possibility of computer modeling, in particular, could function as a pocket veto in the permitting process. Anything can be modeled. But not every model or statistical analysis has enough predictive power or explanatory resolution to actually settle the question which may be of pressing concern. This is an especially troublesome area in ecosystem modeling, which is still very much an evolving discipline without a strong track record of demonstrated predictive power and without a strong tradition of accepted methods for quantifying predictive or explanatory power.

Where models may play their most useful role for permitting decisions is as a prelude to large scale field research, by evaluating proposed designs before they are deployed (or permitted). Modeling can be used to extend the reach of statistical power analysis. The basic approach is to build a model of the system in question using the available current knowledge (including the confidence limits which represent the current uncertainty) and then embed in the model a simulation of the proposed research, including the specifics of the design (*i.e.*, sample sizes, sampling locations, measurement error variation) and whatever is known about spatial and temporal heterogeneity and confounding factors in the system, then submit the simulated data to the planned statistical analysis to see whether the result will have narrow enough confidence limits to provide a useful conclusion and give a reliable answer. This kind of statistical planning can be tedious, but it is nowhere nearly as expensive and time consuming as the actual research, and it can more than pay for itself if it prevents a false start. It would be a reasonable stance for F/PR1 to deny permits for research when such a preliminary analysis shows too low a probability that the research will deliver useful results.

b. *How much (frequency, sample sizes, etc.) of a specific research activity (*e.g., *aerial survey, tagging, biopsy sampling, etc.) is minimally required for management and conservation needs, including population monitoring?*

Fundamentally, the frequency, design, and sample size needed to address a research question will depend on the variation of the parameters measured, the size of the expected effect, and the precision needed to inform management actions. The principle guiding the evaluation of proposed research should be to use as few individuals as necessary, but as many as needed. Although this may not seem helpful in the evaluation of specific research proposals, both researchers and the reviewers of proposals must be guided by these statistical considerations. For some types of research, such as studies to estimate population size and trends, the methods are well developed and it is feasible to conduct a power analysis to indicate the frequency of measurements, sample sizes, and sampling design that will yield estimates with the necessary precision. Methods to use simulation modeling to evaluate the likely success of other types of research are discussed in the section above.

Studies of the foraging ecology of pinnipeds serve to illustrate the potential complexity of information that must be taken into account, and the importance of keeping sight of the motivating question for the research. Foraging behavior is inherently variable, presumably reflecting individual variation in response to ecological conditions in space and time. Thus, deciding on the appropriate number of animals to sample will depend on the temporal and spatial scale over which inferences are sought and the demographic scope of the question. Foraging tactics differ among age classes and sexes in some species and such differences can have strong seasonal and inter-annual patterns. Variability among individuals of a given age and sex can be large and so, even with preliminary data from pilot studies, the decision about how many animals to study may not be easily resolved. Nevertheless, the choice of number and frequency of samples will always be heavily influenced by inter-individual variability. Therefore, the more we know about the magnitude of this variation, the better we can design studies to effectively and efficiently promote the recovery of protected species. Researchers should be required to demonstrate how they have used existing findings to estimate sample sizes and frequency of measurement in designing the proposed study. For example, large numbers of SSL and NFS have been fitted with satellite-linked transmitters over the past decade. Thus, we should expect current proposals to build heavily on this past research to determine how many individuals need to be instrumented to answer a particular question. Where little is known about the variability of a parameter for the species of concern, researchers should be guided by knowledge of better-studied similar species.

c. Should there be different standards or more restrictions placed on research conducted on certain age, sex, or life-history stages or on the geographic or temporal distribution of research effort? If so, what should those limitations be?

All else being equal, the relative degree of protection afforded an individual from the effects of potentially deleterious research should reflect the reproductive value (in the sense of life history theory) of that animal. For example, most adult female mammals have a higher reproductive value than other age/sex classes. Thus, those individuals contribute more to potential population growth and recovery than other animals. Reproductive value is also affected greatly by the breeding system of a species – in highly polygynous species, for example, sub-adult males have relatively low reproductive value. Therefore, particular care should be taken when conducting research on individuals of high reproductive value, such as pregnant and lactating individuals. However, there will be cases when scientific questions important to recovery can only be answered by conducting studies on animals of high reproductive value. For example, if food limitation during lactation is suspected of reducing pup growth and associated survival, and this reduced productivity is thought to be an important factor causing the population to decline, then studies of the foraging behavior and diets of lactating females, and growth and survival of their pups, would seem warranted.

d. What criteria should be used for developing and incorporating new (and thus not previously evaluated) research techniques under research permits?

The first criterion should be that the new research technique is expected to provide information needed to guide management actions to promote recovery that cannot be effectively provided by existing techniques. Secondly, the proposed new method should not involve a high risk of injury or death to individuals or of modifying the behavior of individuals such that the resulting data are compromised. Given these two principles, it follows that the more valuable a new technique is judged to be, the more risk managers should be willing to tolerate in order to develop and test the procedure. Thus, when researchers propose to use an untested method on protected species they should be required to provide a compelling case that the new method is needed. And as a general rule, surrogates should be used before applying the technique to the protected species particularly when the new method is an invasive procedure. However, in the cases of SSL and NFS, both populations are large enough that the use of surrogate species would not seem to be required to develop new research methods that are expected to promote recovery.

3. <u>Coordination of permitted research.</u>

   a. *Assuming permits are issued to multiple individuals, what are the most appropriate mechanisms for ensuring research is not unnecessarily duplicative, and is coordinated to optimize data collection across permits and reduce adverse impacts?*

The evaluation of unnecessary duplication should be done at the permitting stage, by F/PR1 in consultation with NMFS Science Centers. However, in evaluating potentially duplicative work, two points need to be considered. The first is that replication may be needed to address research questions where the statistical power of individual studies is low. Any researcher proposing to pursue such an approach should be required to demonstrate how his/her findings will be merged with those of other researchers. The second point is that ecosystems are dynamic in space and time and therefore our understanding of some aspects of the ecology of threatened and endangered species (*e.g.*, diet, foraging behavior, vital rates) are necessarily conditional. Therefore, proposals by different investigators to study the diet of NFS in different places or times are not necessarily duplicative. By contrast, another study of the diving behavior of either species might well be considered unnecessary unless a strong case can be made that further data are need to inform particular management actions.

Effective coordination and communication among researchers may greatly reduce or eliminate the potential for duplicative research. For example, if two researchers propose to test a new anesthesia protocol, it would be desirable to permit one researcher to apply the method and then report results to the second investigator. The second researcher could gain confidence if the results were favorable, or change the protocol if the first application was unsuccessful. The development of effective means of coordination among researchers working on similar research questions and with the same population of study animals is, in large part, the responsibility of the investigators themselves. Nevertheless, NMFS can facilitate and, in some cases require, such coordination as a condition of the permit. If necessary, NMFS should: determine the optimum scheme for coordination (*e.g.*, the frequency and timing of meetings); require that researchers participate in coordination efforts as a condition of their permit; and assign staff to facilitate and oversee the required coordination efforts.

Although effective coordination and communication among researchers may greatly reduce or eliminate the potential for duplicative research, there is another equally important role that NMFS oversight could have. A weakness of much of the research on SSL is the lack of replication in studies trying to determine the causes of population decline. Typically one site is studied in an area of increasing numbers and another from a decreasing population. Thus any differences in the factors underlying demography are confounded with ecological differences between sites. By encouraging coordination among researchers with similar interests such studies could use much stronger experimental designs that would permit more confident inferences to be made.

This would greatly enhance the value of field research aimed at understanding the causes of population change.

> i. *Alternatively, should NMFS consider limiting the number of permits as a way of ensuring coordination and cooperation among researchers and across projects?*
>
> Presumably this would mean that only a small number of permits, each allowing a wide array of activities, would be issued to a few major agencies and research organizations. Other investigators wishing to work on SSL or NFS would have to function as co-investigators on these permits. This might result in more coordination and cooperation among researchers, but it could reduce the role of F/PR1 in evaluating and authorizing specific research activities. The panel believes that such an approach would be undesirable.

b. *Should researchers operating under different permits (but studying the same or related questions such as aerial survey for population census or biopsy for population genetics) be required to use the same or similar methods to ensure the information collected is comparable (and to increase the sample sizes overall for a given conservation or management objective) and useful for NMFS conservation of the species?*

A standard set of protocols should be established for collecting, storing, sharing, and analyzing data for any research subject that is being investigated by more than one research team. The protocols should require core data to be collected with methods that are either identical or result in compatible data. However, this policy should not prevent new methods from being developed and tested, provided that the core data needed to support conservation objectives are obtained and that any cross-calibration needed to maintain comparability is done.

> i. *If not, how should NMFS compare or use the data from various permit holders in its management decisions and conservation efforts?*

4. <u>Monitoring effects and effectiveness of permitted research.</u>

a. *What types of information or data are needed or should be collected to evaluate effects of permitted research?*

Monitoring the effects of research, and particularly the cumulative effects of research, is quite different than evaluating the effectiveness of permitted research. In the case of effects, the issue is whether the research procedures applied to individuals in some way might compromise the fitness (*i.e.*, survival, growth, or reproduction) of those individuals or of others disturbed by the research. To judge effectiveness, on the other hand, requires that the results of the research be evaluated with respect to management objectives. In other words, did the research result in information that could be used to promote recovery?

The effects of permitted research on individuals can be studied in comparison to a control group and/or with before-after longitudinal studies of individuals with long-lasting identifying marks. There is a well developed body of research, such as Before-After-Control-Impact-Paired study designs, available to address such questions. Some types of research (*e.g.*, behavioral observation) are expected to have minimal effects and therefore short-term follow up monitoring will suffice. Other studies, such as those fitting animals with transmitters for extended periods of time, might reduce foraging efficiency and ultimately affect survival probability or reproductive success. In such studies, foraging trip duration, haul out patterns, body mass gain or condition could be compared with a control group to assess research effects. In the case of lactating females, the growth rate and weaning mass of pups are good measures of maternal performance and can be used to assess the effects of research, assuming that a control group is available. If a research activity has a particularly high potential for adverse effects but shows great promise to address a critical management action, it may be desirable to require an evaluation of the effects of the activity as a condition of the permit.

In some cases, it may be possible to compare survival and reproductive success of treated and control groups to provide a long-term assessment of research effects. Where such studies are possible (*e.g.*, Hawaiian monk seal; Baker and Johanos 2002) they should be encouraged as they represent the gold standard by which research effects will ultimately be judged. Studies that evaluate research effects will also help researchers and permit reviewers by providing guidance as to which proposals need to monitor research effects and how such monitoring might best be accomplished.

i. *Should NMFS look to studies outside the marine mammal field for some of this information?*

It would be useful to examine the broad field of impact assessment to identify potential approaches to study the effects of permitted research on SSL and NFS populations. In addition, there may be examples from other studies of the effects of research methods on threatened and endangered terrestrial mammals that would help guide NMFS in framing this question.

b. *How should permitted research be evaluated to determine whether or how it contributes to species' recovery?*

Ideally, permitted research should be evaluated for its value in promoting recovery by considering the use of its results in guiding the recovery actions specified in a conservation or recovery plan. However, if such plans are outdated or for other reasons do not reflect current recovery needs and priorities, alternative methods will be needed to make such a determination. Alternatives might include implementation plans developed by the agency and/or a recovery team, and review and analysis of current needs by recovery teams, agency biologists, review panels comprised of independent experts, or contractors.

i. *What types of information or data are needed or should be collected to evaluate how well permitted research is contributing to conservation and management needs for the species?*

The requirement here is to link research findings with potential recovery actions and their subsequent effect on population status. If it is impossible to make a direct link to recovery (*i.e.*, status), then it may be possible to look for changes in demographic parameters as a surrogate.

The likelihood that one can make a direct linkage between a permitted research activity and recovery will depend on the type of threat affecting the population – whether the threat is acute or chronic – and how many factors are involved. If a population is directly affected by a small number of well defined and acute threats (such as ship strikes and entanglements for right whales), it may be possible to evaluate the benefit of specific research activities to conservation in terms of the reduction or mitigation of the specific threat. In many cases, however, this will be a difficult task. For example, suppose a recovery action is to reduce the effects of fishing on a protected pinniped. Permitted research is conducted on the diet of the pinniped and a commercial fish species is identified as a commonly consumed prey item. Based on this information, restrictions are placed on the fishery and future population surveys show a positive change in status (*i.e*., a reduced rate of decline or positive population growth). Can we reliably conclude that the permitted research was effective in promoting recovery? This depends on our certainty whether other limiting factors had not changed over time and space. However, one could not dismiss the possibility that the fisheries restrictions helped to change the population's demographics, and that the information provided by the research did help identify a management need.

It seems likely that expert opinion on the appropriateness of the research in reference to a recovery plan (or other appropriate description of research needed in support of recovery) will be most useful to F/PR1 in the short to medium term. Simultaneous testing of multiple hypotheses, with and without the results of a particular category of research results, may provide formal inference with regard to the efficacy of that category of research.

c. *Who should monitor the various research projects and methods to best assess possible effects?*

NMFS, in consultation with the Marine Mammal Commission, is responsible for monitoring research projects to assess possible effects. This evaluation should be informed by data provided by permitted investigators that document the effects, if any, of the specific research procedures conducted.

On the surface it would seem reasonable for permit managers to simply require that researchers proposing to conduct a certain activity monitor their research subjects for impacts that the activity may have caused. Certainly it is reasonable for researchers who have captured animals and conducted invasive studies (*e.g.*, anesthetization, biopsy, tag attachment, *etc*.) to monitor those individuals until they have recovered and resumed normal behavior. However, the assessment of effects beyond such short-term observations of study animals is more difficult.

In the case of Hawaiian monk seals – a population that is small, has a very restricted distribution on land, and is well studied – it has been possible to rigorously evaluate the possible impacts of certain research activities using an experiment-control design (Baker and Johanos 2002). It would be possible to design and conduct a controlled study to assess the effects of a particular research method or set of methods for NFS and SSL at particular sites. In general, however, these species have large populations that range widely and, with the exception of certain age classes and times of year, individuals are not predictably available to be observed.

There are some sources of information that could be explored for insights into possible effects of research activities on NFS and SSL, including the following:

- The movements and behaviors of many animals have been followed using telemetry devices. These studies provide at least two types of relevant data: (1) an estimate of the minimum survival duration of the individual (*i.e.*, at least as long as the telemetry was functioning and indicated normal behavior patterns); and (2) a description of the behavior of the individual while its tag was operational (*e.g.*, movement rates, diving patterns). These data could be analyzed to see if they vary in relation to the type of research that was conducted on an animal prior to release.
- Individually identified (tagged or branded) individuals are often resighted or recaptured (by researchers, subsistence hunters, stranding networks, and fisheries), and their condition and demographic status can be observed or measured and compared with the history of research activities that have been conducted on them.

Both of the possibilities above require a database that provides a complete record of the specific research conducted on each individual animal. All researchers working on protected species should be required as a condition of their permits to report the identification and specific procedures performed any time an individually identifiable animal is taken. A database containing this information should be maintained by F/PR1 and made available for analysis.

Measuring the possible effects of research on SSL and NFS, both of individual projects and cumulatively, will require a substantial research effort. It may be problematic to require that researchers conduct such studies themselves as conditions of their permits. Such research is challenging and requires considerable dedicated effort. In addition, an approach where individuals monitor their own impacts lacks independence. Another approach would be for NMFS to issue a request for proposals to measure and monitor impacts of specific research activities on SSL, NFS, or other protected species. Proposals could be solicited both to mine existing data sources as well as to design and conduct dedicated field studies.

d. *Should permit applications be required to provide monitoring protocols to evaluate the potential effects of the proposed research, or justify why such monitoring is not required, prior to the issuance of the permit?*

Until such time as the effects of particular research procedures are fully evaluated by dedicated study, all research proposals intending to use those procedures should be required to monitor and evaluate their effects. Once the effects of procedures have been evaluated, subsequent proposals could simply refer to those results and not require additional internal evaluation. Dedicated studies designed to evaluate effects of a proposed technique, as described above, would clearly benefit a large number of investigators wishing to use the method. Procedures that have been thoroughly evaluated in similar species should not require further evaluation unless there is reason to believe the effects on the protected species would be quite different or there are questions about their implementation in a particular study.

e. *In the PEIS, research activities were grouped by predicted risk of mortality as estimated based on previous experience of some permit holders (See Chap 4, Mortality Assessment Tables 4.8-1 through 4.8-5). Research activities after capture were grouped from "no risk" (*e.g.*, collecting milk samples, hair, and swabs) or low risk (*e.g.*, collecting blood, attaching flipper tags, enemas and stomach intubation) to medium risk (*e.g.*, biopsy sampling, pulling teeth) and high risk (*i.e.*, surgical procedures). Hot brands were considered in a class of their own, as were procedures that do not involve capture or tissue sampling. NMFS also considered, but did not include in the Programmatic Environmental Impact Statement (PEIS), grouping these activities based on the likely nature or extent of the injury, including if something went wrong during the procedure. For example, ultrasound and other procedures that do not require cutting or puncturing the skin or inserting instruments into the body are not likely to cause injury even if done incorrectly and would therefore be considered "non-invasive" and not likely to cause long-term adverse effects or mortality. Whereas procedures that penetrate the skin, like flipper tag attachment and blubber biopsies, may only cause minor injury but have the potential for infection and would be considered "minimally invasive" with a risk of indirect mortality or other long-term adverse effects. "Major invasive" procedures would be those like muscle biopsies, sub-cutaneous transmitters, or hot brands that result in deep tissue or more extensive injury or have greater risks of excessive bleeding or infection, and thus have a greater potential for long-term adverse effects. Finally, surgical procedures that exposed the body cavity would be a separate category.*

i. *Should research activities (surveys, pup-counts, rookery activities prior to capture) and procedures (activities post capture) be grouped for evaluation of effects?*

There is merit in grouping research activities and procedures for the evaluation of effects provided we know that their potential effects really are similar.

ii. *If so, what is the most appropriate scheme (one of the two above, or something else) for classifying or grouping research procedures for purposes of evaluating impacts or research?*

Although each of the above schemes has advantages, a third option might be considered; one that groups activities and procedures by the kind of effect they are expected to have on the species of concern. For example, surveys and other activities prior to capture and those during and post capture might all cause disturbance resulting in short-term behavioral effects, injury, or mortality. In the end it probably does not matter how activities are grouped. What matters more is the evidence to support the degree of risk classification associated with each activity. A grouping system that includes all research activities and procedures would be preferred to one in which particular procedures are considered separately.

SECTION II. OVERARCHING CONSIDERATIONS FOR PRIORITIZING RESEARCH NEEDS AND ISSUING RESEARCH PERMITS.

The panel was asked to consider research needs for both SSL and NFS. However, the situation with permit issuance is different for these two species because NFS are not ESA listed. For simplicity in the remainder of this report we have restricted our considerations and recommendations to a situation where a species is listed under the ESA, but many of the same principles should apply to non-ESA-listed marine mammals.

1. <u>Current mechanisms for identifying research essential for conservation and recovery.</u>

Section 10(d) of the ESA says “The Secretary may grant exceptions…” to taking prohibitions “…only if he finds and publishes his findings in the Federal Register that (1) such exceptions were applied for in good faith, (2) if granted and exercised will not operate to the disadvantage of such endangered species, and (3) will be consistent with the purposes and policy set forth in section 2 of this Act.” The purpose and policy portions of the ESA (Section 2) say that the Act is intended to provide a means to conserve species, and Section 3 defines "conserve," "conserving," and "conservation" as meaning “to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary.” With regard to issuance of permits for scientific research, read together these sections say that NMFS may issue permits for scientific research on ESA-listed species if it finds that such permits will further the recovery of the species. It is therefore obvious that there needs to be a transparent, effective, and timely mechanism for identifying research essential for conservation and recovery, which should form the backbone of an RPEP.

Recovery plans

Section 4(f)(1) of the ESA says “The Secretary shall develop and implement plans (hereinafter in this subsection referred to as ‘‘recovery plans’’) for the conservation and survival of endangered species and threatened species listed pursuant to this section, unless he finds that such a plan will not promote the conservation of the species.” In general, NMFS has prepared recovery plans for listed marine mammals, and in the specific case of SSL an initial recovery plan was approved in 1992 and a revised plan was approved in 2008.

The ESA goes on to say that recovery plans should include “a description of such site-specific management actions as may be necessary to achieve the plan’s goal for the conservation and survival of the species”, but it does not speak to what research might be needed to identify those site-specific management actions. Nonetheless, it would seem reasonable to expect that recovery plans could provide an important source of information for identifying research essential for conservation and recovery.

Earlier in this report, the panel identified the following reasons why the current generation of recovery plans is not as useful as might be expected in this regard.

- The way in which the existing plans identify actions needed for recovery does not always correspond well with a logical organization of the science questions that need to be answered in support of those actions.
- The time it has taken for development and approval of recovery plans has meant that some actions identified in the plan have become outdated by the time that specific research is proposed to address them.
- Not all of the available data relating to specific research questions have been compiled, analyzed, and reported at the time plans are prepared or at the time permit requests are being evaluated.

The utility of recovery plans for the RPEP could be enhanced. It is quite possible, perhaps likely, that people involved with preparing the plans did not anticipate that the plans would be used in such a way (but see the terms of reference for the most recent SSL Recovery Team in the section below). If providing support and rationale for the RPEP process were a clear intent of the plan it is likely that organization and emphasis could be structured in ways to make it more useful. The alternative is to do a *post hoc* analysis of how research activities correspond with plan actions, as we have done in section I.1 of this report.

Development of the initial SSL recovery plan began in 1990 and the draft plan was approved in December 1992. That plan was 'in force' for more than 15 years. Development of the revised plan began in 2001 and the draft was approved in March 2008. In practice, the development and approval of recovery plans has often been a long process, especially for species facing complex, controversial, and/or poorly understood threats like SSL. And the reality is that long intervals between plan revisions have been common. It is reasonable to expect a recovery plan to provide a thorough general outline of research needed to support recovery efforts, and when they are first approved they may be current about specific needs. However, given the current institutional processes, the analysis of scientific needs in those plans often will not be sufficiently up to date to support decision-making about the appropriateness and necessity of specific research activities as later permit requests arise.

The final point listed above (*i.e.*, incomplete analysis of recent research) is a common problem in evaluating research needs. Undoubtedly those charged with preparing recovery plans make efforts to ensure that the best available data are incorporated into them. But, particularly where there are large, multi-faceted, multi-year projects operating simultaneously, as is the case with SSL, having all the information compiled, analyzed, and available at any point in time is usually not achievable. In some situations unpublished analyses and documents, or personal communications, may be a mechanism for accessing and incorporating more recent information. However, for recovery plans, which are peer-reviewed, published documents intended to guide agency recovery actions for several years, such attributions may not be appropriate because others cannot access and scrutinize the basis used for creating elements of the plan.

Recovery teams

Section 4(f)(2) of the ESA states, "The Secretary, in developing and implementing recovery plans, may procure the services of appropriate public and private agencies and institutions and other qualified persons. Recovery teams appointed pursuant to this subsection shall not be subject to the Federal Advisory Committee Act." This general statement about recovery teams is often clarified in a terms of reference, as in the following for the most recent SSL team: "The current recovery team has been established as a body of experts to revise the recovery plan for Steller sea lions and to advise NMFS on issues related to their status and conservation. The revised recovery plan will serve as a basis for future recovery efforts, prioritization of research to ensure that new information will contribute toward the greatest research needs, and effective monitoring to allow NMFS to track the status of Steller sea lions and the factors that may affect them." The terms of reference for the current Hawaiian Monk Seal (HMS) Recovery Team state: "The role of the HMSRT is to advise the Pacific Island Region Office (PIRO) Regional Administrator on issues concerning the implementation of the recovery plan. HMSRT responsibilities include reviewing and commenting on recovery and research activities, offering advice related to implementation of scientific and management activities in the plan, and providing advice on prioritizing recovery activities. HMSRT input may include actions such as evaluating research and management programs, assessing the efficacy of specific recovery efforts, evaluating species status and listing classification when appropriate, and recommending new or emergency actions needed to enhance the recovery of the species."

It is evident that NMFS intends for recovery teams to provide ongoing input on recovery needs in addition to what role they may play in recovery plan development. Evaluation and prioritization of research needs are two of the continuing roles expected of the teams, and it is therefore reasonable to expect that teams could play a role in the RPEP.

Members of this panel have considerable experience with NMFS-appointed recovery teams for marine mammals, and we agree that input from such teams can be helpful for evaluating research. However, whether or not teams will be appropriate and useful for the RPEP depends on a number of factors, including the following:

- Team makeup—The ESA does not speak to the makeup of teams other than to say that members must be "qualified persons." Terms of reference may specify that team members are experts in science and resource management. In fact, some teams have been comprised almost entirely of such experts, while other teams in addition contain a number of "stakeholder representatives." In either event, the experts in science are commonly people who are actively doing research on the species in question, which is understandable since they embody much of the relevant scientific knowledge. Even though these are people of high integrity, it is hardly fair to ask them for unbiased evaluations of what research is essential for recovery. Stakeholders, by definition, have their own sets of interests.
- Team priorities—NMFS has relied heavily on recovery teams for the preparation of recovery plans, and initial drafts of both SSL plans were prepared by teams. Teams may also be asked for advice on important and complex recovery issues such as critical habitat designation, reclassification of threat level, etc. Providing the specific scientific advice needed in support of the RPEP is unlikely to occur unless it is identified as a high priority for team action.
- Team time constraints—Associated with the issue of priorities for a recovery team is the issue of time constraints. NMFS does not compensate members for their time working on recovery teams. Those working for agencies and organizations with an

official role in recovery may do so as part of their normal work duties, but others must participate *pro bono*. Based on the panel's experience with this project, providing the scientific evaluation and advice needed for the RPEP is a substantial endeavor, particularly for a situation like that SSL, and it is unrealistic to expect that level of effort from a recovery team comprised of volunteers.

In spite of the issues described above, in the panelists' experience there have been times when recovery teams have provided NMFS with the type of advice needed for the RPEP. During the 1990s the HMS Recovery Team commonly did detailed critiques of ongoing research and research needs at their annual meeting. Those efforts were fruitful largely for the following reasons: 1) the team was comprised mostly of experienced scientists who were not themselves actively engaged in monk seal research; 2) the factors affecting the population's status at that time were fairly well identified; 3) the components of the research that were intrusive addressed clearly understood needs; 4) the bulk of the research being done and proposed was highly focused in scope, and largely managed directly by a NMFS lab in a program with acknowledged credibility; and 5) the research program presented comprehensive and timely summaries of results to the recovery team at annual meetings. The original SSL Recovery Team performed a somewhat similar role in the years following approval of their initial plan. The recent SSL Team has been unable to effectively fill this role, partly because of the team's composition and also because the factors affecting the population are more complex and their relative impacts are largely unknown. Furthermore, the Team that prepared the revised SSL plan was subsequently disbanded.

2. <u>Decision system for issuance of permits.</u>

The questions put to the panel are framed in terms of research permits for SSL and NFS, but these same questions could arise in connection with research permits affecting almost any protected species. Looking to the future, given the prospects for climate change and the reality of growing human populations and growing demands for resources, it is easy to imagine that the number of species with protective listings will increase. With a little more imagination we could consider the possibility that increasingly the conservation of some of those species might involve diffuse ecosystem effects whose mechanisms are poorly understood, so that the consequences of some interventions might be increasingly difficult to predict. This future, then, will increase the quantitative burden on the permitting process just through sheer numbers of research programs needing permits. It may also increase the burden in a qualitative way, if a need is perceived for more experimental management, and more intrusive research, in order to cope with the crucial uncertainties for species that are failing to recover after the more straightforward protections and interventions have been tried and proven insufficient.

In a future with increasing numbers of permit applications to consider, and conceivably with applications for permits for research that arguably might be considered more 'risky,' reliance on an *ad hoc* process, such as we are participating in now, could encounter a log jam. Clear and effective standards consistent with the needs for effective management will be needed for a smoothly running permit evaluation process.

What will be needed is a permitting process that taps into the expertise that is already on board in the institutional compliance with ESA—ideally the recovery teams. After all, the scientists on those teams should be the people who have the opportunity to become immersed in the knowledge about the species and its management. Ideally, this knowledge should have been synthesized, in a quality-controlled way, in the recovery plan for the species in question.

The decision process would also benefit from quantitative standards that can be used by F/PR1, so that, to the extent possible, the decisions could be data-driven and fact-driven, thus reducing the dependence on judgment calls that are difficult to document and defend.

Therefore, it is the view of the panel that there are three questions that F/PR1 must address prior to issuing a permit to work on an ESA-listed species:

1. Is the proposed research sound and has it been vetted through scientific peer review?
2. Will findings from the proposed research likely be useful for promoting recovery, again as determined through scientific peer review with reference to the available recovery plan and any updated information?
3. Are the procedures being proposed humane and do they represent best animal care and husbandry practice as evaluated by an IACUC?

Under such a system, F/PR1 would **not** be responsible for the determining what research is needed or what represents best practice. Nevertheless, F/PR1 needs to know what current research needs and priorities are and what the best practices are. Review of proposals or study plans by IACUCs could serve to ensure that best practices are to be used. Understanding current research needs and priorities will require that F/PR1 coordinate effectively with NMFS Science Centers. What we are proposing here represents a departure from the current system in which F/PR1 is unreasonably burdened with both evaluating research priorities and best practice research procedures and ensuring that proposed research is consistent with the requirements of the ESA and MMPA.

NMFS asked the panel the following basic questions.

- What research and monitoring are needed to meet management needs?
- What methods and protocols, including sample size, are appropriate?
- How should the research be coordinated?
- How should effects and effectiveness be monitored?

The idealized answers to these questions could be fairly simple, though admittedly the implementation may not be simple at all, and there may be serious legal and policy hurdles. In the following sections of this report the panel presents the idealized simple answers first, and then comes back to the implementation challenges and policy requisites.

What research and monitoring are needed to meet management needs?

The research and monitoring needed to meet the management needs should be the research and monitoring that has been identified in the recovery plan as essential. The recovery plan should explain why that research is essential, and it should explain how the outcome of that research and monitoring will guide decisions about specific recovery actions. The premise is that until the research is done, launching those recovery actions would be imprudent because of the uncertainty, but the research is expected to resolve enough of the uncertainty that reasonable choices could be made among the potential actions.

What methods and protocols, including sample size, are appropriate?

The appropriate methods, protocols, and sample sizes are whatever it takes to obtain sufficient resolution of the uncertainties to justify subsequent choices of action, provided (1) comparative analysis shows that the methods and protocols selected have the lowest possible risk to the population among the potential methods and protocols that could get job done, and (2) risk benefit analysis shows that the risk to the population from the research and monitoring activities is more than compensated for by the conservation benefits of implementing the recovery actions that the research results will select and guide. While computational frameworks for doing such analyses are available they have not been applied to the current situation with issuance of permits for research on ESA-listed marine mammals.

How should the research be coordinated?

The research should be coordinated by NMFS, the responsible agency, to ensure that permitted research does match up with the research needs identified in the recovery plan, and to ensure that the methods and protocols proposed will get the job done, minimize impact within that constraint, and pose a risk that is more than compensated by the expected conservation utility of the expected results.

How should effects and effectiveness be monitored?

Effects, in the sense of impacts, of the research must be monitored as part of the research program itself to verify that the actual impacts are consistent with the impacts predicted in the RPEP. The effectiveness of the research is judged by its delivering the resolution needed to support the management decision at which it is directed. If events show that the impacts or resolution are not as expected, or if changing circumstances make the management question moot, the risk-benefit analysis should be revisited, and the permit itself should be re-evaluated on that basis.

Implementation challenges in an imperfect world

The reader will doubtless have recognized by now the large distance between the idealized world of the above short answers and the actual world of the current recovery plans and the current technical analysis capacity of F/PR1.

Recovery plans, as they actually exist, tend to be inclusive rather than deeply discriminating in the cataloging of research needs. They seldom present a documented logical “if-then” structure linking anticipated research results to choices among potential recovery actions in the recovery plan. At best, therefore, we would face a need for much more demanding technical guidance provided to recovery teams regarding those sections of a recovery plan. However difficult and time consuming this may be, the bottom line is ‘who better than the recovery team to identify research needs’ and ‘where better than the recovery plan to document and explain those needs.’

The prospective evaluation of sample size is a common academic requirement for graduate students planning their thesis research. The basic statistical tool is called ‘power analysis.’ Oddly, the larger the research program, the less common it is for this kind of analysis to be done. It definitely should be done for ESA-permitted research, since the stakes are so high. If too small a sample is taken, the research will not obtain the needed statistical resolution while a larger sample than needed may cause larger impact than was necessary. The statistical expertise needed to do this kind of analysis is available at the NMFS Science Centers and within many other research groups.

The risk-benefit analysis will place the greatest strain on personnel allocation within NMFS. There are few people within the agency with this capability, and most of those few are the same people who are in demand for running complicated stock assessments. NMFS will need to cultivate a new cadre with these talents in the years ahead.

The SSL and NFS research programs well exemplify the problem of not having current information at hand for permit decision-making—a number of research programs have been conducting a wide range of studies, over many years. The challenge of using that information to evaluate what research should be permitted requires knowing both what has been done and what has been learned. Investigators working on marine mammals are required to submit annual reports of their research to F/PR1. It would seem relatively straightforward to obtain specific information on what has been done from those reports, but it is not clear that the information is being reported and stored in the most useful ways. Review and modification of these procedures may be warranted.

Developing an understanding of what has been learned through already permitted research—and therefore what more needs done—is an even greater challenge. During 1991-2005 researchers from the National Marine Mammal Laboratory (NMML) and their cooperators attached satellite-linked telemetry instruments to 179 SSL in Alaskan and Russian waters. While sample sizes for individual regions, age classes, and years were generally not large, 97 SSL less than a year old were tagged. In the case of NFS, such instruments were attached by NMML to 665 animals in the Bering Sea, including 320 put on adult females. These figures do not include attachments that were done by other research programs operating in Alaska and Russia. While there have been a number of publications that analyze and report subsets of these research efforts, to the knowledge of the panel there has been no formal attempt to synthesize all of the results and use that synthesis to decide when, where, and on what type of animals future deployments are needed.

Policy obstacles

The applicable ESA provisions create a tension between a prohibition on research that would “operate to the disadvantage” of a listed species, and the mandate to “use...all methods and procedures which are necessary” for recovery. The notion of a short-term impact of research (which could be interpreted to "disadvantage" the population) being balanced by the long-term use of the resulting information, which is "necessary" for recovery, is a complication that the legal system has not yet confronted directly. There will almost certainly be reluctance to issue permits on this basis until the policy issues have received very thorough airing, and appropriate standards of evidence and procedures have been adopted for how the applicable risk benefit analysis should be done, and what the results of that risk benefit analysis must show in order to justify the permit. Considering the subtleties and the complexities, it is to be expected that this policy discussion will take a long time. It would not be too soon to start the discussions now.

Until such policy is clarified, any research permit that entails more than a 'negligible' impact on the population may be difficult to defend, and open to controversy, if challenged. And, at the moment, even the definition of negligible is not entirely clear in an ESA context. 'Potential biological removal,' which is a provision of the MMPA, not the ESA, could offer some relevant ideas, but transfer of those ideas to ESA would not be automatic.

Ultimately, acceptance of a risk-benefit framework (*e.g.*, a management strategy evaluation), which issues permits for research that is genuinely necessary even though it poses a non-trivial short term risk, will require an atmosphere of trust in the institutions and the decision system. Consider a non-threatening example, a marking program. The marking process itself may be somewhat intrusive and pose some level of risk to the individual animals. The justification of a marking program could be that it provides needed information not readily available at lower cost to the species, about movements, survival rates, and reproductive rates. But note that this justification assumes that an adequate resighting program will be implemented and maintained for as long as necessary after the animals are marked, and that the results of the research (*i.e.*, the new information about movements, or survival, or reproductive rates) really will be used to make a significant management decision. In the absence of binding commitments to implement the follow up and to use the results, this becomes a matter of trust.

When the risk posed is small, as it may be in many marking programs, the trust that is asked for may not be much of a strain. But as the risk of the research goes up, the certainty that might be demanded about the commitment for management to follow up might go up as well. The policy developments that might nurture this trust include guidelines that are more explicit about the planning function of a recovery plan document, and ways of making some components of the plan more binding.

3. Options for the near term.

In-house review by NMFS

Much of the expertise on research needed to support recovery of ESA-listed marine mammals resides within NMFS. NMFS could choose to conduct the RPEP by consulting entirely with their own staff. This could have advantages with regard to administrative efficiency and perhaps cost. However, there are obvious disadvantages: NMFS researchers would be taken away from their normal work to assist in the RPEP; NMFS researchers would be in a conflict of interest situation reviewing their own planned work; and the RPEP would not take advantage of the spectrum of knowledge and experience available from non-NMFS scientists. An alternative to avoid some of these disadvantages would be for NMFS to contract with an appropriate person(s) or organization(s) to provide them a scientific analysis of ongoing and needed scientific research which they could then use in the RPEP.

Expert review panels and workshops

The original SSL Recovery Team began considering the need to revise the original recovery plan in 1996, four years after the plan was approved. The team recognized that much research had been done on SSL in the intervening period and that it would be necessary to evaluate that information in depth prior to making a new set of recommendations about necessary management and research actions. As a result the team designed and conducted four review workshops, funded by NMFS, to bring together representatives of past and ongoing SSL research programs to present their results to a panel of experts including both SSL researchers and other qualified biologists. The reports from those review panels (SSLRT 1997a,b; SSLRT 1999a,b) provided as up-to-date as possible summaries of work that had been done as well as recommendations for what more should be done to support recovery needs. It is the opinion of the panel that this represents the level of effort and detail required to support a scientifically defensible RPEP.

There are a number of variations on how review panels and workshops could be designed and used to provide the background analysis needed for the RPEP. The optimum design will depend on a number of factors including: 1) the frequency with which NMFS feels that such analyses need to be done (*e.g.*, annually, every five years, etc.); and 2) whether in-depth reviews are needed only for specific problem situations like SSL or if they are needed for all marine mammal research permits. If in-depth review will be needed only occasionally for particular species an *ad hoc* approach such as that coordinated by the first SSL Recovery Team might be adequate. However, if such reviews will be needed more frequently and for all species NMFS might consider organizing, and providing funding for, a standing expert panel committed to spending the necessary effort on this issue in a continuing and timely manner.

SECTION III. RECOMMENDATIONS OF THE PANEL

- F/PR1 should not attempt to operate the RPEP using only their in-house assets.
- F/PR1 should review, and modify if needed, permit reporting requirements and procedures for storing permit report data.
- F/PR1 should use existing mechanisms, or if necessary establish additional mechanisms, to enforce permit provisions and, if necessary, revoke, suspend, or modify permits.
- F/PR1 should require that researchers participate in coordination efforts as a condition of their permit, and should assign staff to facilitate and oversee the required coordination efforts.
- Proposals or study designs of projects involving research on ESA-listed marine mammals should be peer-reviewed to ensure scientific integrity prior to permit requests being submitted to F/PR1.
- To the extent possible, NMFS should rely on recovery plans and recovery teams to provide guidance on the types of research needed to support recovery programs for ESA-listed marine mammals.

- NMFS should review the current format and content of recovery plans, and make modifications to recovery plan guidance, as needed to improve their utility for use in the RPEP.
- In convening recovery teams, NMFS should attempt to maintain independence and diversity of the scientists appointed. Mechanisms should be provided to avoid conflicts of interest in identifying and prioritizing research needs. F/PR1 should participate in the recovery team/recovery plan process.
- NMFS should provide support for meta-analyses of datasets when such analyses can help identify information gaps and research needs. Two examples are monitoring and measuring research impacts and use of telemetry to study habitat use.
- NMFS should develop a system to use expert panels to provide review of science needed for the RPEP when such information is not provided by a recovery plan or recovery team.
- F/PR1 should ensure that any permitted research complies with all relevant legislation and policies (*e.g.*, ESA, MMPA, AWA).
    - Compliance with humane practices requirements could be accomplished by requiring that research procedures be pre-approved by a competent IACUC.
    - Compliance with the requirement that the research serve a recovery need should be evaluated with reference to the recovery plan, recovery team consultation, and expert panels. The evaluation itself may best be done using a risk-benefit analysis conducted by experts outside of F/PR1.

SECTION IV. LITERATURE CITED

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APPENDIX A NFS Research Questions and Conservation Actions

Research questions for conserving and recovering the eastern Pacific stock of northern fur seals and conservation plan actions relating to each question. Numbers are those assigned to actions in the conservation plan. SMALL CAPS=highest priority; *italics*=moderate priority, times new roman=lowest priority.

What is the status of the population?

3.1.2 CONTINUE REGULAR COUNTS OF ADULT MALES AND ESTIMATES OF PUP PRODUCTION ON ST. PAUL, ST. GEORGE, AND BOGOSLOF ISLANDS
3.1.3 ESTIMATE PUP SURVIVAL
3.1.5 ESTIMATE STOCK VITAL RATES
3.1.6 *Evaluate behavioral/physiological studies*
3.1.7 *Continue comparative studies on other islands*
3.1.9 PROMOTE JOINT RESEARCH AND COLLABORATIVE PROGRAMS
3.4.1 REEVALUATE CARRYING CAPACITY
3.4.6 *Ecosystem modeling*

What are the life history characteristics of the population?

3.1.1 *Analyze fur seal teeth*
3.1.4 EVALUATE MARKING PROGRAMS
3.1.5 ESTIMATE STOCK VITAL RATES
3.1.6 *Evaluate behavioral/physiological studies*
3.1.7 *Continue comparative studies on other islands*

What factors are affecting growth of individuals and population productivity?

2.4 *Conduct studies to quantify effects of human activities (e.g. research, hunting, tourism, vehicles, discharges, facilities) at or near breeding and resting areas*
2.6.1 *COMPILE AND EVALUATE EXISTING POLLUTANT DATA*
2.6.2 *Monitor and study environmental pollutant exposure*
2.7.1 STUDY THE NATURAL AND ANTHROPOGENIC INFLUENCES ON FUR SEAL FEEDING ECOLOGY
2.7.2 Evaluate pelagic fur seal sampling
2.7.4 DETERMINE IMPACT OF FISHERIES
3.1.6 *Evaluate behavioral/physiological studies*
3.2.1 *Compile and evaluate existing disease data*
3.2.2 *Determine and mitigate disease effects*
3.4.5 *Quantify environmental effect on behavior and productivity*
3.4.6 *Ecosystem modeling*

What factors are affecting mortality?

1.1.1 *Continue disentanglement program to reduce mortality and harm to fur seals entangled in marine debris*

1.1.2 *Remove marine debris and incorporate surveys of debris in northern fur seal habitat*
1.1.3 Examine the fate of entangling debris
1.2.1 Implement and evaluate fishery and marine mammal observation programs in the North Pacific Ocean and Bering Sea
1.2.2 Review observer and incidental take data
1.3.1 MONITOR AND MANAGE SUBSISTENCE HARVESTS
1.3.2 *Develop and implement harvest sampling programs*
1.3.3 *Compile and evaluate existing harvest data*
1.3.4 IDENTIFY AND EVALUATE ILLEGAL HARVESTS
2.4 *Conduct studies to quantify effects of human activities (e.g. research, hunting, tourism, vehicles, discharges, facilities) at or near breeding and resting areas*
2.6.1 COMPILE AND EVALUATE EXISTING POLLUTANT DATA
2.6.2 *Monitor and study environmental pollutant exposure*
2.7.3 *Report fishery interactions*
2.6.3 Evaluate carcass salvage programs
3.1.8 Conduct appropriate studies to assess the impact of predation (*e.g.*, killer whales, Steller sea lions, sharks) on fur seal populations
3.2.1 *Compile and evaluate existing disease data*
3.2.2 *Determine and mitigate disease effects*

What habitats are used for important ecological functions, and what factors are affecting those habitats?

3.3.1 COMPILE AND EVALUATE AVAILABLE HABITAT-USE DATA
3.3.2 CONDUCT OCEANOGRAPHIC AND FISHERY SURVEYS BASED ON PELAGIC FUR SEAL HABITAT USE
3.4.2 *Continue and evaluate Pribilof Islands Sentinel Program*
3.4.3 COMPILE AND EVALUATE EXISTING PHYSICAL ENVIRONMENTAL DATA
3.4.4 Select appropriate environmental indices
3.4.6 *Ecosystem modeling*

APPENDIX B NFS Permitted Research

Permit No. 782-1708-3 National Marine Mammal Laboratory

<u>Specific Research Objectives:</u> [note some research specific to San Miguel Island is not considered because San Miguel fur seals were not included in the NFS Conservation Plan]

1. Count the number of territorial and idle bulls on each rookery of the Pribilof Islands and on Bogoslof Island.
2. Estimate the number of pups born on the Pribilof Islands and Bogoslof Island.
3. Assess the frequency and causes of pup and non-pup mortality at selected rookery sites.
4. Monitor condition indices (weight and length), nutritional status and physiological health, and bacterial and viral pathogens of northern fur seal pups and non-pups as a method of evaluating early and late cohort "health".
5. Monitor the diet of northern fur seal females and sub-adult males on all major rookery islands.
6. Use satellite (time/depth and location) transmitters and radio telemetry for obtaining information on the location and behavior of various age and sex classes of fur seals at sea. Information from these instruments will be compared to real-time information obtained on the oceanographic data (*e.g.*, temperature, and salinity) and fisheries survey data to provide more complete understanding of the fur seals' habitat requirements.

<u>Location and Timing:</u>
Research will be conducted May-December, 2003-2007 on the breeding rookeries of the U.S. population of northern fur seals. These include St. Paul, St. George, and Otter Islands of the Pribilof Islands group; and Bogoslof Island in the Bering Sea.

<u>Specific Research Activities:</u>
Census adult males by counting from a distance
Capture and restrain pups on land
Clip fur from pups
Collect and examine dead pups and non-pups
Weigh and measure pups
Take ultrasound measurements of blubber of pups
Take blood samples from pups
Take fecal loops and swabs from pups
Mark fur of pups
Attach flipper tags to pups
Gastric lavage pups
Attach satellite-linked tags to pups
Capture, restrain, and sedate non-pups on land
Weigh and measure non-pups
Extract tooth from non-pups
Take ultrasound measurements of blubber of non-pups
Take blood samples from non-pups
Take fecal loops from non-pups
Take swabs from non-pups
Mark fur of non-pups

Attach flipper tags to non-pups
Collect milk samples from non-pups
Attach satellite-linked tags, TDRs, VHF tags to non-pups
Insert stomach temperature transmitter in non-pups
Recapture non-pups
Measure and ultrasound recaptured non-pups
Collect milk and blood samples from recaptured non-pups
Collect feces by enema from recaptured non-pups
Collect teeth and tissues from dead seals
Collect scats

Permit No. 881-1893 Alaska Sealife Center
Specific Research Objectives:
1. To monitor fur seal pup movements, diving behavior and prey ingestion from their rookery departure in November (post-weaning) to June using satellite telemetry.
2. To characterize fur seal pup habitat-associations by combining tracking and dive data with bathymetry and satellite remote sensing of hydrographic features.
3. To collect data on juvenile and adult northern fur seal diet, body condition, and movements and habitat associations utilizing pelagic captures.

Location and Timing:
Field seasons for initial captures of pups on the rookery will occur during the months of October and November in each year of the project. recaptures would most likely occur between the months of May and November. Research will be conducted on the Pribilof Islands, St. Paul and St. George Islands, and Bogoslof Island, in the Bering Sea.

Specific Research Activities:
Capture, restrain, and sedate pups on land
Take blood samples from pups
Take skin samples from pups
Take blubber samples from pups
Take muscle biopsies from pups
Take fecal loops and swabs from pups
Take vibrissae from pups
Take hair from pups
Take nails from pups
Measure isotope dilution in pups
Measure bioelectric impedance in pups
Take ultrasound measurements of blubber of pups
Attach flipper tags to pups
Mark fur of pups
Attach satellite-linked tags to pups
Place stomach temperature transmitters in pups
Capture, restrain, and sedate seals at sea
Sample and process as described above for pups
Take ultrasonographs of female reproductive tracts of seals caught at sea

Permit No. 715-1884 Andrew Trites, NPUMMRC

Research Objectives (specific objectives are not listed in the permit application):
Activity 1. Behavioral foraging ecology of northern fur seals. The primary goal is to determine what pelagic habitat is used by lactating northern fur seals in the eastern Bering Sea and how they use it. *Activity 2*. Demographic and behavioral studies of northern fur seals. This study will establish a marked population of known aged northern fur seals that will be resighted in future years to estimate vital rates and provide information about the feeding and behavioral ecology of northern fur seals. We will establish whether the population decline is caused by a high mortality of young animals or mature individuals, or whether it is related to reproductive failure. *Activity 3*. Assessing changes in body size and annual growth increments of teeth of northern fur seals. Body size of male northern fur seals taken in subsistence harvests on St. Paul and St. George will be compared with historical measurements taken since 1911 to assess the current condition of fur seals relative to carrying capacity.

Location and Timing:
Research will occur in all months and seasons, but will be concentrated in the months of July – September while fur seals are on land. Northern fur seal research will be conducted on the Pribilof Islands (St. Paul and St. George islands) and Bogoslof Island. Activity 3 will be conducted on both Pribilof Islands. Activity 2 will be initiated on St. Paul Island, and will be expanded to St. George Island and Bogoslof Island in years 3-5 subject to available funding and review of protocols established in years 1-2. Activity 1 will be conducted on St. Paul Island and will be expanded to St. George Island and Bogoslof Islands in years 3-5 subject to available funding.

Specific Research Activities:
Activity 1
Capture and restrain adult females on land
Take measurements of adult females
Attach electronic tags to adult females
Collect scats
Activity 2
Capture and restrain pups on land
Take measurements of pups
Take swabs from pups
Take blood from pups
Take vibrissae from pups
Take skin samples from pups
Take blubber sample from pups
Inject tetracycline into pups
Attach flipper tags to pups
Insert coded wire tag in pups
Capture, restrain, and sedate adult females and subadult males on land
Take measurements of adult females and subadult males
Take swabs from adult females and subadult males
Take blood from adult females and subadult males
Take vibrissae from adult females and subadult males

Take skin samples from adult females and subadult males
Take blubber sample from adult females and subadult males

Attach flipper tags to adult females and subadult males
Insert coded wire tag in adult females and subadult males
Remove postcanine tooth from adult females and subadult males
Collect scats
Activity 3
Measure animals taken in subsistence harvest
Collect teeth; determine age and measure growth rings

Permit No. 715-1883 Andrew Trites, NPUMMRC

Specific Research Objectives:

a. Obtain baseline measures of growth and resting and daily metabolism in young northern fur seals to enhance predictive bioenergetic models.
b. Determine the fasting capabilities of young fur seals, and the interaction between fasting and thermal demands.
c. Establish blood biochemistry and hematology parameters that can be used as bioindicators of nutritional stress in northern fur seals.
d. Determine the pattern of tissue catabolism during periods of under-nutrition.
e. Determine the effect of dietary changes on reproductive hormones.
f. Estimate the maximum food intake levels of young northern fur seals and their ability to alter intake to compensate for changes in food quality and availability.
g. Determine the species-specific calibration coefficients (enrichment values) needed to determine diet from fatty acid signature analysis.
h. Quantify digestion and recovery correction factors required to accurately describe diet from hard fecal remains (scat analysis).
i. Determine the effectiveness of using stable isotope and fatty acid signature analyses to determine diet in wild fur seals

Location and Timing:
Initial takes and holding/evaluation are anticipated to be for 5-7 days in October 2007 on St. Paul Island (57° N, 170°W) in the Bering Sea, Alaska. This time of year corresponds to when fur seals are weaning. With the assistance of experienced NMFS researchers, 8 female pups that are approaching weaning will be captured from the fringes of one rookery on St. Paul Island (possibly Zapadni Reef, Kitovi, Vostochni, English Bay or Reef rookery).

Specific Research Activities:
Capture female pups and hold in facility on island
Remove female pups from island to captivity
Take blood samples and conduct oral and eye exams on rookery
Take blood samples at captive colony
Manipulate diets of captive seals including fasting
Take morphological measurements of captive seals
Take blubber biopsies of captive seals

Measure blubber of captive seals with ultrasound
Determine body condition of captive seals with isotopes
Measure metabolism of captive seals in metabolic chamber

Permit No. 1066-1750 LGL Alaska Research Associates
Specific Research Objectives:
Evaluate the importance of marine debris as a source of mortality to fur seals on the Pribilof Islands.

Location and Timing:
Field work will be done during July and August 2004 and intermittently until June 2005 in the Pribilof Islands, AK in the Bering Sea.

Specific Research Activities:
Round up subadult male seals and count by age class
Remove entangling debris from subadult males
Characterize the type and weight of debris and the extent of the wound created by the debris
Capture solo pups and adult females and remove entangling debris

Permit no. 1118-1881 Aleut Community of St. Paul Island
Overall Objectives:
Biosample Program--The objective of the Biosample Program is to collect, salvage, and/or accept (from subsistence users) and to distribute biosamples from dead stranded, subsistence hunted and beach cast marine mammals for both research and educational purposes. An example of the sort of research projects that will be undertaken by ECO with the biosamples is marine mammal tooth collection and aging. In addition, external requests for tissue samples from accredited researchers occur regularly (*e.g.* for genetic or toxicology investigations). *Marine Mammal Tooth Collection* --The objective of this project is to provide an accurate age determination for all seals taken during the St. Paul subsistence harvest. *Entanglement Program-* The primary goal of this project is to address the persistent problem of northern fur seal entanglement in derelict fishing gear and other marine debris. The activities proposed under this permit are designed to: a) mitigate effects of entanglement in marine debris on the Pribilof Islands through the capture and release of entangled northern fur seals; b) track the rate of entanglement as a long-term measure of the success of any efforts intended to reduce fur seal mortality due to entanglement, and c) identify the source of entangling debris to better target management efforts to prevent future fur seal entanglement. *Tanam Amgignaa (Island Sentinel) Program*--The objectives of the Tanam Amgignaa (TA) or Island Sentinel Program are to advance stewardship and active responsibility of and for the Pribilof Islands ecosystem. The program provides a centralized community forum to promote environmental education, outreach and cultural awareness through community-based monitoring.

Location and Timing:
Research will take place on St. Paul, Otter, and Walrus Islands and Sea Lion Rock of the Pribilof Islands group in the Bering Sea, Alaska, throughout the year.

Specific Research Activities:

Collect hard tissues, soft tissues, and/or whole carcasses from subsistence kills and natural deaths—provide samples to other investigators for analysis (tooth ageing, diets)
Estimate entanglement rates
Disentangle seals
Monitor parameters of the fur seal environment on St. Paul Island

Permit no. 1119-1882 Aleut Community of St. George Island

Overall Objective:

Biological Sample Collection--The Aleut Community of St. George Island Traditional Council has regularly assisted NMML staff and other independent researchers in the collection and distribution of biological samples from numerous marine mammal species, including but not limited to northern fur seals, harbor seals, and Steller sea lions. It is our desire to continue to collect and distribute biosamples from marine mammal species for research. *Marine Mammal Tooth Collection*--The Aleut Community of St. George Island has participated in the collection of teeth for research purposes during the local fur seal subsistence harvest since the cessation of the commercial fur seal harvest. As a part of our current fur seal subsistence harvest monitoring program, the Aleut Community of St. George Island Traditional Council via their Kayumixtax ECO department collects a sample of teeth from harvested male fur seals to be aged at the NMML. *Entanglement Program*--The primary goal of this project is to address the persistent problem of northern fur seal entanglement in derelict fishing gear and other marine debris. The activities proposed under this permit are designed to: a) mitigate effects of entanglement in marine debris on the Pribilof Islands through the capture and release of entangled northern fur seals; b) track the rate of entanglement as a long-term measure of the success of any efforts intended to reduce fur seal mortality due to entanglement, and c) identify the source of entangling debris to better target management efforts to prevent future fur seal entanglement. *Island Sentinel Program*--The objectives of the Tanam Amgignaa (TA) or Island Sentinel Program are to advance stewardship and active responsibility of and for the Pribilof Islands ecosystem. The program provides a centralized community forum to promote environmental education, outreach and cultural awareness through community-based monitoring.

Location and Timing:

Research will take place throughout the year on St. George Island of the Pribilof Islands group in the Bering Sea, Alaska

Specific Research Activities:

Collect hard tissues, soft tissues, and/or whole carcasses from subsistence kills and natural deaths; provide samples to other investigators for analysis (tooth ageing, diets)
Estimate entanglement rates
Disentangle seals
Monitor parameters of the fur seal environment on St. George Island

APPENDIX C SSL Research Questions and Recovery Actions

Research questions for conserving and recovering Steller sea lions and recovery plan actions relating to each question. Numbers are those assigned to actions in the recovery plan. SMALL CAPS=highest priority; *italics*=moderate priority, ***bold italics***=medium priority, times new roman=lowest priority.

What is the status of the population?

1.1.1 ESTIMATE TRENDS FOR PUPS AND NON-PUPS VIA AERIAL SURVEYS
1.1.2 CONTINUE TO MONITOR POPULATION TRENDS ON PRIBILOF ISLANDS (PARTICULARLY THE WALRUS ISLAND ROOKERY) VIA AERIAL SURVEYS OR LANDBASED PUP COUNTS
1.2.1 *Continue to estimate survival, natality, and immigration/emigration rates through a branding/resight program*
1.2.3 ***Develop an age-structured population model using medium format photos from aerial surveys***
1.2.4 *Develop methods and determine reproductive rates including pregnancy and parturition rates*
1.3.1 ***Examine the effects of season, age, and sex on body condition***
1.3.2 *Develop improved indices of health, body condition, and reproductive status using chemical methods (e.g., hematology serum chemistries, and endocrine monitoring)*

What are its life history characteristics?

1.2.1 *Continue to estimate survival, natality, and immigration/emigration rates through a branding/resight program*
1.2.3 ***Develop an age-structured population model using medium format photos from aerial surveys***
1.2.4 *Develop methods and determine reproductive rates including pregnancy and parturition rates*
1.4.1 *Develop improved live capture techniques for general research needs*
5.7.4 *Document local knowledge and cultural science (Traditional Ecological Knowledge, TEK) pertaining to sea lions to better understand changes in sea lion movement (local and seasonal), feeding patterns and prey, seasonal haulouts, predation and ecosystem dynamics*

What factors are affecting growth of individuals and population productivity

1.4.1 *Develop improved live capture techniques for general research needs*
1.4.2 ***Develop improved non-lethal sampling techniques to assess health***
2.3.1 *Collect and analyze scat samples and stomach contents to determine prey consumption*
2.3.2 *Develop stable isotope and fatty acid methodologies to assess prey consumption*
2.3.4 *Evaluate all information on sea lion foraging areas and develop a description of foraging needs*
2.4.3 ***Distinguish how natural and anthropogenic factors influence marine ecosystem dynamics and subsequently sea lion population dynamics***

2.5.1 Determine the physiological diving capabilities and evaluate how this limits the ability to forage successfully
2.5.2 *Determine the energetic costs to foraging sea lions*
2.5.3 *Assess the nutritional value of prey by species, season, and area including digestibility and overall value to sea lions*
2.5.4 ***Develop an energetics model to investigate the interrelationships between prey availability and sea lion growth, condition, and vital rates***
2.6.5 *Assess the response of sea lions to changes in prey distribution and availability*
2.6.7 ***Explore the use of ecosystem based (multi-species) stock assessment models to set fishery catch limits to ensure adequate prey resources for a recovered sea lion population***
3.5.2 Monitor and minimize unintentional takes associated with research activities
4.1.1 ***Conduct epidemiological surveys***
4.1.2 ***Develop and implement methods for parasite evaluations***
4.1.3 ***Develop and implement methods to test immune system functioning***
4.1.7 ***Develop models to simulate disease impacts based on energetics, physiology, abundance and demographics.***
4.2.1 *Design a contaminant research and management plan*
4.2.2 *Collect contaminant samples from free-ranging sea lions and in environmental 'hotspots'*
4.2.3 *Examine blood and tissue samples for evidence of contaminant linked endocrine effects including free-ranging and captive work*
4.2.4 *Develop models to simulate contaminant impacts and effects based on energetics, physiology, abundance and demographics*
5.7.3 *Analyze carcasses from subsistence harvest to assess age, body condition, and other relevant information to ensure safety of carcasses for human consumption*

What factors are affecting mortality?

3.1.1 Monitor and evaluate incidental take in commercial and recreational fisheries through observer and self-reporting programs
3.1.2 Monitor and evaluate incidental take in non-commercial fisheries
3.2.1 Monitor intentional take via shoreline surveys for carcasses near suspected conflict "hotspots" and by encouraging reporting of illegal shooting through NMFS's enforcement hotline
3.3.1 Develop and promote non-lethal means of deterring sea lions from hauling out on docks
3.5.1 Coordinate research efforts to reduce potential for unnecessary or duplicative research-related takes
3.5.2 Monitor and minimize unintentional takes associated with research activities
4.1.1 ***Conduct epidemiological surveys***
4.1.2 ***Develop and implement methods for parasite evaluations***
4.1.3 ***Develop and implement methods to test immune system functioning***
4.1.4 *Evaluate causes of mortality by examining dead and live animals of all age and sex classes for disease from various sources across the geographic range and in all seasons*
4.1.7 ***Develop models to simulate disease impacts based on energetics, physiology, abundance and demographics.***
4.3.1 ***Understand predator life histories, biology and ecology through studies of free-ranging and captive animals***

4.3.2 *Determine killer whale diets*
4.3.3 ***Develop methods to obtain samples from live killer whales***
4.3.4 ***Expand the stranding network to increase samples of killer whales available for research***
4.3.5 *Determine killer whale distribution and behavior across the North Pacific*
4.3.6 *Estimate numbers of killer whale ecotypes in time and space*
4.3.7 ***Develop models to simulate predation rates based on killer whale energetics and abundance of Steller sea lion demographics (NOTE--this is really what it says)***
5.3.1 ***Continue and expand the Alaska stranding network to increase coastal coverage and community involvement in monitoring sea lion mortality***
5.3.2 ***Survey selected areas for stranded animals***
5.3.3 ***Expand tissue sampling efforts to improve the information obtained from dead sea lions***
5.3.4 ***Monitor the incidence and impact of entanglement in marine debris***
5.7.1 *Co-manage subsistence harvests and evaluate the efficacy and accuracy of using retrospective subsistence harvest surveys*
5.7.4 *Document local knowledge and cultural science (Traditional Ecological Knowledge, TEK) pertaining to sea lions to better understand changes in sea lion movement (local and seasonal), feeding patterns and prey, seasonal haulouts, predation and ecosystem dynamics*

What habitats are used for important ecological functions and what factors are affecting those habitats?

2.2 Redefine and catalog rookery and haulout sites and ensure their protection
2.3.3 *Deploy instruments to obtain fine scale data on sea lion foraging habitat*
2.4 Determine the environmental factors influencing sea lion foraging and survival
2.4.1 ***Assess the relationships between oceanographic profiles or features and sea lion foraging ecology***
2.4.3 ***Distinguish how natural and anthropogenic factors influence marine ecosystem dynamics and subsequently sea lion population dynamics***
2.6.1 ***Improve groundfish stock assessment surveys to determine seasonal and inter-annual patterns of prey abundance, distribution, and movement at scales relevant to sea lions***
2.6.2 Assess competition for prey with sympatric consumers (*e.g.*, gadids and flatfish, fur seals, harbor seals, other marine mammals, and seabirds)
2.6.3 *Utilize groundfish fishery observer data to assess the spatialtemporal distribution of the fishery*
2.6.4 *Assess effectiveness of sea lion closure zones around rookeries and haulouts using small-scale experiments*
2.6.6 *Evaluate and implement current or equivalent fishery regulations to protect foraging habitat and prey resources for sea lions*
2.6.7 ***Explore the use of ecosystem based (multi-species) stock assessment models to set fishery catch limits to ensure adequate prey resources for a recovered sea lion population***

Appendix C. Example Internal Initial Scoping Document for Issuance of a Research Permit

The following is an example of a template that NMFS Permits Division will use to document the internal scoping process for determining the appropriate level of NEPA analysis for a proposed permit for research on Steller sea lions or northern fur seals.

A. Description of Proposed Action**:** NMFS proposes to issue a scientific research or enhancement permit pursuant to Section 104 of the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1361 *et seq*.) and Section 10(a)(1)(A) of the Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 *et seq*.).

B. Action Area: [name or short description of geographic location of research].

1. List of threatened and endangered species and designated critical habitat that may be present within the area
2. List of non-target species that may be present within the area
3. List of areas considered “ecologically critical” or unique in any other way: [e.g., historic or cultural resources, park land, prime farmlands, wetlands, wild and scenic rivers, essential fish habitat]

C. Duration of Action: [when would permitted activities commence and when would they end, e.g., permit expiration date].

1. Project timing [i.e., describe time and frequency (e.g., monthly from January through March) of field season or project]

D. Purpose of and Need for Action: [e.g., provide an exemption from the MMPA take prohibitions so that applicant can collect information on species’ abundance and distribution, in accordance with requirements of Section 117 of MMPA for marine mammal stock assessments.]

1. Project description: [brief description of activities, e.g., conduct aerial and vessel surveys and whether their effects are adequately evaluated in PEIS].
2. Project Objectives: [short summary of study objectives, as provided by applicant].

{option 1} PR1 NEPA determination: issuance of the proposed permit is consistent with the activities identified in the Preferred Alternative of the Final Programmatic Environmental Impact Statement for Steller Sea Lion and Northern Fur Seal Research (NMFS 2007) and no further NEPA analysis is required for issuance of the permit, which will contain terms and conditions consistent with the PEIS and NMFS Record of Decision.

[NOTE: stop here if determination is that permit is within scope of PEIS]

{option 2} PR1 NEPA determination: the proposed research activities are outside the scope of the preferred alternative \ or\ the effects are not evaluated in the Final Programmatic Environmental Impact Statement for Steller Sea Lion and Northern Fur Seal Research (NMFS 2007). A tiered environmental assessment will be prepared to evaluate the potential environmental impacts of permit issuance. PR1 will follow the guidance in the NOAA NEPA

Handbook, NAO 216-6, Policy Directive 30-131, and the HQ Quality Assurance Plan regarding content and format for the EA. The following outlines the scope, purpose and need, and a range of alternatives to be included in the analysis, and other relevant factors identified in Section 4.2 of the HQ Quality Assurance Plan.

E. Alternatives, including Proposed Action:
1. Proposed Action: Issue permit with standard permit conditions
2. No Action: Deny permit
3. [others; e.g., issue permit with special mitigation and monitoring requirements]

F. Issues within scope of the EA: This EA will evaluate impacts according to the factors identified in section 6.01b of NAO 216-6 for determining the significance of a major federal action. PR1 has preliminarily identified the level of potential impacts under the Proposed Action as follows:

1. impacts on biological environment
    a. target species
    b. non-target species
    c. biodiversity, ecosystem function, etc.
2. impacts on physical environment [e.g., loss or destruction of significant cultural or historical resources; changes in land use patterns; alteration of wetlands, EFH, refuges]
3. impacts on social and economic environment
    a. public health and safety [consider impacts on water use and quality; air quality; traffic and transportation; noise; risk of exposure to hazardous materials, wastes, and other contaminants; risk of contracting disease; risk of damages from natural disasters]
    b. Environmental Justice [e.g., result in inequitable distributions of environmental burdens or access to environmental goods]
4. resources identified, but that will not be analyzed and why
5. degree of uncertainty [e.g., new techniques]
6. level of controversy [e.g., has there been or is there likely to be litigation; has the public objected to similar or related projects]
7. precedent setting or decision in principle [e.g., involve any irreversible or irretrievable commitments of resources; predispose agency to permitting or funding a future project]
8. cumulative impacts [related to other past, present or reasonably foreseeable future actions with individually insignificant but cumulatively significant impacts]

H. Other Affected Agencies and Parties: PR1 has determined that no other offices or parties would be affected by or need to be involved in the NEPA process for this action. \or\ PR1 has determined that the following parties and agencies should be involved in the NEPA analysis and review process:
1. [e.g., name of cooperating agency; relevant jurisdiction; type of involvement]
2. [e.g., name of agency or party; type of involvement]

I. Preliminary Schedule:
1. [e.g., Circulate draft EA for internal review by [date]]
2. [e.g., Final EA and FONSI by [date]]

J. [optional] Proposed List of Agencies, Organizations, and Persons to Whom Copies of the EA will be Sent:

1. [e.g., stakeholders, plaintiffs, Tribal governments, State Agencies]

Appendix D:
Guidance for Internal Review of Applications

Contents

Guidance for Internal Review of Applications

(December 2008)

1.0 Introduction

This guidance accompanies the “application score sheet” (Attachment 1) and is only for applications for a permit to “take”[1] marine mammals for research or enhancement. Such permits are issued under Section 104 of the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C 1361 *et seq.*) and the regulations governing the taking and importing of marine mammals (50 CFR Part 216). For “takes”[2] of marine mammals listed as threatened or endangered under the Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 *et seq*.), permits are also[3] issued under section 10(a)(1)(A) of the ESA and the regulations governing the taking, importing, and exporting of endangered and threatened species (50 CFR Parts 222-226).

The purpose of the initial review of an application by the permit analysts is to evaluate how well the applicant has addressed the applicable permit issuance criteria set forth in the MMPA, ESA, and National Marine Fisheries Service (NMFS) regulations. The following guidance shall be used, in conjunction with the “application score sheet,” in evaluating which permit issuance criteria are applicable and whether the application is consistent with all applicable criteria.

The “application score sheet” indicates the applicable section of the MMPA, ESA, or NMFS regulations for each criterion. The sheet also provides a reference to the sections of the application where the applicant’s corresponding response should be located. Note that just as a checklist is not sufficient record of a deliberative process, the “application score sheet” does not take the place of a decision document. Permit analysts should use this guidance in conjunction with the “application score sheet” to develop a summary of application review memorandum or other appropriate written record of application review and findings relative to the issuance criteria.

2.0 Rating Applicant Responses

For the purpose of application review and use of the “application score sheet” the permit issuance criteria are separated into four categories: (1) general, (2) MMPA requirements, (3) ESA requirements, and (4) other applicable laws. Within each category rank specific statutory and regulatory criteria from 0 to 4 according to how well the applicant’s responses address a criterion. The ranks are as follows: (0) Not Applicable; (1) Not Addressed (either no response given or response does not relate to the question); (2) Poorly Addressed; (3) Adequately Addressed; or 4) Well Covered.

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[1] Under the MMPA, “take” is defined as to "harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect."

[2] Under the ESA, “take” is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."

[3] As a matter of unwritten policy, NMFS typically issues a joint MMPA/ESA permit to applicants requesting take of ESA-listed marine mammals, rather than separate permits under each statute. This is done as a courtesy to the applicant, to streamline both the application process and the permit reporting requirements.

Note that when an applicant provides no response to a question or section of the application, the appropriate rank is "(1) Not Addressed," regardless of whether the question or section is applicable to their activity. A criterion may only be ranked as "(0) Not Applicable" both when PR1 has appropriately determined the question or section not applicable and the applicant has briefly explained why the question or section is not applicable to their activity.

For criteria that PR1 determines "not applicable" to a particular application, and for which the applicant has adequately explained why it is not applicable, the appropriate rank is "0." If the applicant provided text in response to a question or section of the application but the information provided is irrelevant to a criterion or is otherwise non-responsive, the appropriate rank is "(1) Not Addressed." If a criterion is applicable, but not addressed, the application should be considered incomplete and the summary of review memo should identify all such responses and recommend the application be returned to the applicant for additional information.

2.1 General Criteria

The issuance criteria identified as "general" relate to whether: (1) the application is for species within NMFS jurisdiction, (2) the activities are consistent with the specified sections of the Acts, and (3) the applicant has followed the appropriate application procedures. Evaluating these criteria should be the first step in review of an application before proceeding to review of the details of the application for consistency with the specific permit issuance criteria under the MMPA, ESA, and other applicable laws.

Note that the general criteria do not correspond to how well the applicant responded to specific questions: that determination is made when evaluating each specific statutory or regulatory criterion. The general criteria only relate to whether the applicant provided a response. Thus, the only applicable ranks are "1" or "4."

NMFS regulations for permit application submission (50 CFR 216.33) require persons seeking a special exception permit to submit an application that is "signed by the applicant" and provides "in a properly formatted manner all information necessary to process the application." NMFS has developed written application instructions specifying the form and manner in which applications must be submitted (OMB No. 0648-0084, Expires 09/30/2009[4]).

In reviewing the application for compliance with these general criteria, consider the following:

G.1. Was the application submitted using the current version of the application instructions?

- If not, rank the response as "1" and end your review here with a recommendation for the application to be returned because the request was not submitted in a properly formatted manner.
- If yes, then rank the response as "4" and proceed to next criterion.

[4] These OMB-approved instructions are reviewed and renewed periodically by NMFS. Analysts should refer to the most current OMB-approved instructions at the time an application is under review.

G.2. Was the application signed by the applicant (i.e., by the PI if applicant is an individual or by the Responsible Party and PI if applicant is an institution/organization)?

- If not, rank the response as "1" and end your review here with a recommendation for the application to be returned for appropriate certification by applicant.
- If yes, then rank the response as "4" and proceed to next criterion.

G.3. Are the activities for "purposes of scientific research" <u>on</u> marine mammals?

- If not, rank the response as "0" and end your review here with a recommendation for the application to be returned because activity is not consistent with provisions of section 104 of MMPA.
- If yes, rank the response as "4" and proceed to next criterion.

G.4 If takes of threatened or endangered species are requested, are the activities for "scientific purposes" under ESA?

- If not, rank the response as "0" and end your review here with a recommendation for the application to be returned because activity is not consistent with provisions of section 10(a)(1)(A) of ESA.
- If yes, rank the response as "4" and proceed to next criterion.

G.5 Are the marine mammal species for which take is requested under NMFS jurisdiction? (Note that the U.S. Fish and Wildlife Service has jurisdiction for MMPA section 104 and ESA Section 10(a)(1)(A) permits for walrus, manatee, polar bear, and sea otter.)

- If not, indicate whether the applicant is seeking or requires a joint permit with FWS or end your review here and recommend application be returned because species are not within NMFS jurisdiction.
    - Also note whether non-mammal species are proposed for taking, and whether the applicant may require additional permits from other agencies.
- If yes, rank the response as "4" and proceed to next criterion.

2.2 MMPA Requirements Criteria

The issuance criteria identified as "MMPA requirements" relate to the specific statutory and regulatory requirements for permits issued pursuant to Section 104 of the MMPA. In ranking how well the applicant's responses address these criteria, consider whether the applicant provided an appropriate level of evidence in support of their assertions, including references to other material (e.g., peer-reviewed publications) that supports the validity of their assertions. In evaluating "whether" a criteria is met, consider the how's and why's of the applicant's responses.

In reviewing the application for compliance with the MMPA requirements criteria, consider the following:

M.1. Did the applicant justify that taking of a marine mammal or marine mammal stock is necessary?

- Did they adequately explain <u>why</u> their hypothesis cannot be tested or question answered without taking a marine mammal, such as
  - through examination of existing data or information (on same or other species)
  - through use of non-protected species (species that are not protected under the MMPA or listed under the ESA)
  - without live animals (e.g. via computer modeling or tissue culture)
- For activities that involve capture or sampling of wild animals, did the applicant also adequately explain why they could not use animals already in captivity or rehabilitated animals?

<u>Criteria related to statutory definition of *bona fide scientific research*</u>

M.2. Has the applicant provided a clearly stated hypothesis to be tested, or question to be answered?
- This is important because an assessment of whether methods are appropriate, sample sizes are justified, outcomes are likely to benefit conservation, etc. is difficult in the absence of a well defined hypothesis or question.

M.3. Has the applicant demonstrated that (how or why) the proposed methods are appropriate for the stated hypothesis/question?
- Consider that a well-planned study uses methods consistent with the type of data needed to address the question.
- Consider not only the manner of collecting the samples (e.g. aerial vs. land-based surveys, permanent vs. temporary marks, tissue sampling vs. observations) but the temporal and spatial nature of the sampling.
  - For example, is the study proposed for the appropriate time of year or geographic location relative to the hypothesis?

M.4 Has the applicant demonstrated that (how or why) the sample size[5] is appropriate (e.g., neither too small nor too large, and not directed at an inappropriate segment of the population or species) for the stated hypothesis/question?
- If the size is too small for the hypothesis/question, consider how an inadequate or insufficient sample size would affect the outcome of the study.
  - Keep in mind that some experimental studies will necessarily begin with small sample sizes in early phases.
- Consider the magnitude of the risks to the individual, stock, or species.
  - Are the risks to the individual, stock, or species justified given an inadequate data set?
  - Is it still worthwhile to collect the information and if so, why?
  - If the size is too large, what is the rationale?

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[5] Note that for applications to conduct presence or abundance surveys, a sample size justification should focus not on the number of animals that would be counted, but on the number of surveys that would be conducted and necessary to make a robust population estimate or informed decision about presence.

- Consider how the applicant justified the need to sample within a specific sex, age classes, life history stage, sub-population, etc. relative to their specific hypothesis or question.

M.5. Has the applicant demonstrated that (how and why) the sample size is achievable given their resources and the expertise of the personnel listed?

- Consider past permit performance: has the applicant previously been successful? If not, what impact has this had on achieving the study goals? What changes have they made that make it more likely they will succeed this time?

NOTE: the following three criteria, while interrelated and inextricably linked, are interpreted within the statutory definition of "bona fide" as being either/or requirements, such that an applicant technically need only satisfy one, but not all, of the three. However, by the nature of the criteria, projects that do not satisfy one, will also likely not satisfy the others.

M.6. Has the applicant demonstrated how their activity would contribute to the basic knowledge of marine mammal biology or ecology, including the relative importance of the contribution and how likely they are to be successful in achieving their stated objective?

- Consider how well the applicant has demonstrated their knowledge of the relevant literature and placed their study in the proper context.
- It is not sufficient to simply claim a link. The applicant should
  - provide a logical argument for how their sample collection (and subsequent analysis) would result in robust data and
  - describe how that data would fill specific information gaps or significantly enhance existing knowledge.

M.7. Has the applicant demonstrated how their activity would identify, evaluate, or resolve a specific conservation problem for marine mammals?

- It is not sufficient to simply claim a link. The applicant should provide a logical argument for how their sample collection (and subsequent analysis) would result in robust data that could be used to inform (in a meaningful way) a specific conservation or management decision.

M.8. Has the applicant demonstrated that (why) their activity is not unnecessarily duplicative?

- Have they explained
  - how their study is unique,
  - how their study builds upon previous studies in a meaningful way
  - if it duplicates a previous study, why the duplication is essential to understanding the issue or validating the theory

M.9. Has the applicant demonstrated that (why) they are reasonably likely to publish or otherwise make their results available to the public in a reasonable period of time?

- Evaluation of this criterion should include review of the applicant's publication history and consideration of how likely their study is to be publishable.
- Consider that peer-reviewed publications typically have standards, similar to these issuance criteria, regarding a clearly stated hypothesis, appropriate sample sizes and methods, and significance or relevance of the information.

<u>Criteria related to statutory definition of humane</u>

M.10. Are the methods described in sufficient detail to evaluate potential effects?

M.11. Has the applicant appropriately identified potential effects, both short and long-term, of each procedure, as well as cumulative or synergistic effects?

M.12. How does the applicant's alternatives search substantiate that their methods are those with the least possible potential for pain and stress?

M.13. How has the applicant demonstrated that their proposed mitigation measures would avoid or minimize adverse effects of each activity to the maximum extent practical?

M.14. Has the applicant explained how their monitoring or research is appropriate to evaluate effects?

<u>Criteria related to "manner of taking"</u>

M.15. Has the applicant described all of the relevant details of each proposed method?
- Refer to Appendix 1 for level of detail that would constitute a "well-covered" response for commonly requested activities.

M.16. Does the application specify the number and kind of marine mammals proposed for taking by each activity and, within each activity, by species, stock, sex, age, and life-history stage?
- Note that level of detail appropriate for this response may depend on the nature of the hypothesis or question. At a minimum, the applicant must specify both the total number of animals that would be affected and the total number of times an animal would be exposed to a given activity.

M.17. Does the application specify the locations of the taking with sufficient detail to confirm presence of species, and marine mammal stock identity?
- Note that information on location is also needed for evaluation of environmental impacts overall.

M.18. Does the application specify the period during which the activity would be conducted, including overall project start and end dates, as well as sufficient detail regarding seasons, frequency, etc. to confirm presence of species, stock identity, sex, age, and life-history stages likely to be affected?

- Note that information on time and frequency is essential to evaluation of cumulative effects.

Criteria related to "Lethal Taking"

M.19. If lethal taking, either intentional or unintentional, is requested, or is otherwise possible due to nature of the activity, how has the applicant justified that non-lethal methods are not feasible?
  - Note that feasibility is not based on "ability," as in cost or ease of doing something, but to possibility, as in an alternative exists, regardless of cost or ease of carrying it out.

M.20. If lethal taking from a depleted stock is requested or otherwise possible due to nature of activity, how has the applicant justified that the results of their research will directly benefit that stock or species, or otherwise fulfill a specific critically important research need identified by NMFS?
  - Note that an adequate justification for "directly benefit" should directly link the information to be gained from the study to a specific management or conservation action that would likely result in an improvement in the status of the stock or species.

M.21. Has the applicant appropriately identified and adequately explained the processes for research-related mortality and associated probabilities of such mortality?
  - Note that there can be more than one process that can lead to mortality, such as immediate effects of a drug interaction versus longer term effects of an infection or internal bleeding, or an injury that hinders feeding.
  - In evaluating this application, also consider past records for the same or similar activities, by the same applicant and others.

2.3 ESA Requirements Criteria

The issuance criteria identified as "ESA requirements" relate to the specific statutory and regulatory requirements for permits issued pursuant to Section 10(a)(1)A) of the ESA. In ranking how well the applicant's responses address these criteria, consider whether the applicant has provided an appropriate level of evidence in support of their assertions, including references to other material (e.g., peer-reviewed publications) that supports the validity of their assertions. Consider the how's and why's of the applicant's responses in evaluating "whether" a criteria is met.

In reviewing the application for compliance with the ESA requirements criteria, consider the following:

Criteria related to "in good faith"

E.1. Has the applicant demonstrated their understanding of and intent to act consistent with the requirements of the ESA, NMFS implementing regulations, and permit terms and conditions, and is their capability to successfully carry out their research consistent with what they purport to accomplish?

- Note that for applicants with previous NMFS permits, you must review the administrative records for those permits in evaluating whether the applicant has a history of permit compliance and successful completion of permitted studies.
- For capability, also consider the experience and expertise of personnel, and adequacy of facilities and other resources necessary to carrying out the research.

Criteria related to "Will not operate to the disadvantage"

E.2. Has the applicant demonstrated that their activity would not hinder the recovery, result in harm that would put the species at increased risk, or otherwise result in loss or damage that would delay recovery?

- Consider whether the applicant has searched for and considered adverse effects on individuals (e.g., physical injury, death, reduced or failed reproduction, reduced growth, impaired foraging ability, depressed immune response) known to be associated with the proposed research in general, and specific procedures in particular?
- What are the consequences of these adverse effects on the survival, longevity, or reproductive capacity of individuals?
- What are the consequences (in context of numbers of animals affected and overall population size) of these adverse outcomes for the threatened or endangered populations the individuals represent?

Criteria related to furthering bona fide and necessary or desirable purpose, or enhancing propagation or survival

E.3. Has the applicant explained how the results of their research would directly benefit the species; contribute significantly to fulfilling a critically important research need identified by NMFS for the subject species; identify, evaluate or resolve a specific conservation problem for the subject species; or contribute significantly to the general understanding of the subject species' biology or ecology?

- Does the hypothesis or question address a well-defined conservation problem?

E.4. Has the applicant demonstrated appropriate knowledge of the listing status and current population trends and threats for the subject species?

- Appropriate knowledge is essential in designing a well-planned study and putting the study results in the proper context for determining how they would contribute to conservation.
- A well-covered response
  - defines the significance or extent of the problem (using statistics or supporting facts)
  - identifies likely causes of the problem and its effects
  - defines the specific part of the problem that would be addressed by the study and how

E.5. Has the applicant appropriately identified possible adverse impacts of their research on the listed species and how the impacts would be minimized?

- It is not sufficient for the applicant to indicate impacts are "negligible," "minimal," "short-term," etc. without defining what is meant by these terms.
  - For example, "short-term" could mean the animals recover within minutes or before the next breeding season. The possible implications for these two examples could be very different.

E.6. Has the applicant demonstrated that the personnel to be involved in the taking have appropriate prior experience with the same or similar species and have demonstrated success with the proposed or analogous methods?

- Consider that the experience of personnel who will be engaged in activities with higher potential for serious injury or mortality should be commensurately greater than that of personnel who will be engaged in "lower risk" activities such as behavioral observations.

E.7. Has the applicant demonstrated why their research cannot be conducted using a species or stock that is not listed under the ESA?

E.8. Has the applicant provided appropriate documentation for captive born animals or stated their intent to remove animals from the wild?

E.9. If animals are to be removed from the wild, or captive propagation is proposed, has the applicant made appropriate provisions for the ultimate disposition of the animals at the conclusion of the project or program?

- For release of animals to the wild, this should include discussion of
  - how the applicant would ensure animals are free of disease and other pathogens that could pose a risk to animals in the wild
  - how (and for how long) animals would be monitored post-release
  - how the applicant would ensure animals are not imprinted on humans or have developed other behavioral abnormalities that would hinder their survival in the wild
- For propagation, does the applicant have adequate (by APHIS standards) space for the maximum number of progeny that could result?

2.4 Other Applicable Laws Criteria

The issuance criteria identified as "other applicable laws" relate to the requirements of other federal, state, and local permits, licenses, approvals, and consultation requirements necessary to issue the permit or conduct the proposed research. When it is the applicant's responsibility to secure the necessary approvals, NMFS is obligated under National Environmental Policy Act (NEPA) to ascertain whether the applicant has secured or is seeking other federal, state, or local approvals for their action. In ranking how well the applicant's responses address these criteria, consider how convincing or well supported by references the argument is.

In reviewing the application for compliance with the other applicable laws criteria, permit analysts shall consider the following:

O.1. Has the applicant demonstrated compliance with the requirements of their institution's Animal Care and Use Committee (ACUC), pursuant to the Animal Welfare Act or justification for why such compliance is not required?

- Note, the applicant may submit, as proof of compliance, a copy of the protocols submitted to their ACUC and the corresponding written approval of the Committee. In this case, permit analysts should confirm that the descriptions of protocols submitted to the ACUC are identical to those in the permit application.

O.2 Has the applicant demonstrated that they have applied for, secured, or will apply for other federal, state, and local permissions required for their conduct of the research?

<u>Criteria related to National Environmental Policy Act determination</u>

In general, consider whether the applicant gave responses with sufficient detail for PR1 to determine whether NMFS issuance of the permit is suitable for a categorical exclusion, is covered by an existing programmatic environmental assessment (EA) or an environmental impact statement (EIS), or for PR1 to prepare an EA or EIS.

O.3. Has the applicant described the location of their research with sufficient detail for PR1 to evaluate potential environmental impacts?
Consider, for example, whether there is sufficient information to determine whether:

- the action would occur in or near geographic areas that may be considered "ecologically critical" such as national or state parks, wildlife refuges, wild and scenic rivers, essential fish habitat, designated critical habitat for any listed species, etc.;
- there could be cumulative impacts when this action is added to existing impacts and those that are reasonably foreseeable;
- the physical features of the area could exacerbate or alleviate potential adverse impacts of proposed research methods;
- other species of wildlife or protected plants could be present or otherwise affected, and how.

O.4. Has the applicant described their methods in sufficient detail to fully evaluate the potential effects on target species, non-target species, and other features of the environment?

- For work on land, the applicant should describe methods of ingress and egress to field sites.

O.5. Has the applicant appropriately identified the potential effects, both short- and long-term, of each procedure, as well as cumulative or synergistic effects?

O.6. Has the applicant identified how their proposed post-activity monitoring is appropriate to evaluate the effects of their activity and to ensure recovery of animals post-handling or sampling?

3.0 Scoring the Application

After reviewing the application and ranking the applicant's responses, compute the scores for each criterion and the application overall. Scores for individual criteria are calculated by multiplying the rating by the weight. The overall score for an application is the sum of these scores.

> **Note:** Applications with a total score below 1.8 out of 4 for MMPA criteria and below 1.72 out of 4 for ESA criteria should be returned to the applicant with an explanation of the deficiencies and not considered further. This is based on ranks of "2" (poorly addressed) or less for all responses, and where some criteria (such as lethal taking) may not be applicable.

Note that incomplete applications do not receive a final score. A lack of response to any specific criterion, regardless of its weight, is sufficient reason to consider an application incomplete and return it to the applicant without further processing.

Note also that if the research involves taking both marine mammals and ESA-listed species, including threatened or endangered marine mammals, the applicant must satisfy both the MMPA and the ESA requirements because permits are required under both statutes.

Weights were assigned to each criterion on the score sheet based on their importance in the final decision regarding whether issuance of the permit is consistent with all legal requirements. While all applicable permit issuance criteria must be met, they are not necessarily equally important. For criteria with lower weights in the final decision, a rating of "poorly addressed" would have less influence on the decision whether to issue a permit than such a rating for a criterion of higher weight. For some criteria, a rating of "poorly addressed" may be cause for returning the application for additional information or explanation by the applicant.

3.1 General Requirements

The responses to the General Criteria are not weighted or considered in scoring the application overall. The general criteria reflect whether the applicant has provided responses as required, but not how responsive the information is relative to the criteria. Failure to receive a rank of "4" for any of these general criteria means the application should not be considered further under this guidance. Therefore, the following applications should be returned and not considered further

- incomplete (responses ranked as "not addressed")
- improperly formatted
- inappropriately signed
- not for species under NMFS jurisdiction
- not for scientific research[6] on marine mammals

[6] Recall that this document is only for review of applications for permits to conduct scientific research. If the application was submitted as a scientific research permit request, but the activity proposed is related to another type of activity under Section 104 of the MMPA (e.g., public display, commercial or educational photography), the applicant should be advised to resubmit using the appropriate format and the application should be reviewed under the applicable criteria.

3.2 MMPA Requirements

Assuming the applicant has provided responses to all of the MMPA Requirements Criteria, the application should be scored as follows:

- If NMFS determines a criterion not applicable, it is not factored into the final score.
- If NMFS ranks that the applicant's responses to details of the manner of taking (criteria M15 – M18) as "poorly addressed, the application should be returned for additional details so that the permit will accurately reflect the needs of the research with respect to species, location, duration, etc. Otherwise, multiply the rank by the weight and enter the score in the appropriate column.
- If NMFS ranks the applicant's responses to the following criteria "poorly addressed," the application may be returned to the applicant for additional information or NMFS may make the application available for public review and comment to get additional information. If the applicant's responses to these criteria are ranked as "3" or "4" then multiply the rank by the weight and enter the score in the appropriate column.
    - Justification that taking of marine mammals is necessary (M1)
    - Justification that project is consistent with bona fide definition (M2 – M9)
    - Justification that manner of taking is consistent with the MMPA's definition of humane (M10 – M14)
    - Justification that non-lethal methods are not feasible (M19)

3.3 ESA Requirements

Assuming the applicant has provided responses to all of the ESA Requirements Criteria, the application should be scored as follows:

- If NMFS determines a criterion not applicable, it is not factored into the final score.
- If NMFS ranks the applicant's response to the following criteria "poorly addressed," the application should be returned to the applicant for additional information or explanation. These criteria reflect positive findings that must be made by NMFS or positive showings that must be made by the applicant, pursuant to the statute or regulations. If the applicant's responses to these criteria are ranked as "3" or "4" then multiply the rank by the weight and enter the score in the appropriate column.
    - The permit has been "applied for in good faith" (E1)
    - The permit "will not operate to the disadvantage of listed species" (E2)
    - The permit would further a bona fide and necessary or desirable scientific purpose; or enhance propagation or survival (E3)

3.4 Other Applicable Laws

These criteria are not directly related to permit issuance requirements the applicant must satisfy under the MMPA and ESA, and they are weighted correspondingly lower. However, these criteria reflect information necessary to processing the application, including determinations NMFS must make under NEPA.

- If the applicant fails to demonstrate compliance with Animal Welfare Act (AWA) or applicable requirements for other federal, state or local permits necessary to conduct the research, it is not necessary to return the application.

- If NMFS ranks the applicant's responses to the NEPA determination criteria as "poorly addressed," the application should be returned to the applicant for additional information or explanation.

As with the MMPA and ESA criteria, multiply the rank for each of these "other applicable laws" criteria by the weight and enter the score in the appropriate column.

4.0 Documenting Analyst Recommendations

After ranking and scoring an application using the "score sheet," complete a "summary of review memorandum" to document your review and recommendations.

If	You should
responses to G1 – G5 are ranked as "0"	recommend the application be returned and not considered further
Responses to M1 – M14 or M19 are ranked below "3"	recommend the application be returned for additional information, and withdrawn if no response within 60 days or recommend the application be published in *Federal Register* for public review with note that application may contain insufficient information
responses to M15 – M18 are ranked below "3"	contact the applicant for additional information; allow 60 days for response
response to E1 – E3 are ranked below "3"	contact the applicant for additional information; allow 60 days for response
application is scored >1.8 (MMPA) and >1.72 (ESA)	recommend the application be published in *Federal Register* for public review and comment
application is scored <1.8 (MMPA) and <1.72 (ESA)	recommend the application be returned for additional information, and withdrawn if no response within 60 days

When returning an application for additional information, indicate which parts of the application require additional information or responses. If an applicant does not respond to requests for additional information within 60 days, consider the application withdrawn. Withdrawn applications are not considered further. Applicants who wish to pursue the activities in a withdrawn application must submit a new application for review.

When returning an application that will not be considered further, prepare a letter for signature by the Division Chief which specifies the reasons for return (e.g., species not within NMFS jurisdiction).

APPENDIX 1: “Well-Covered” Sampling Methods Details

Descriptions of sampling methods for these commonly proposed research activities should contain the following details to be ranked as “well covered” responses.

- For **aerial surveys**, including with **photo-id**: Description (including latitude and longitude) of the survey area(s); time(s) of year for the surveys; type of survey craft (e.g. fixed wing, helicopter, etc.); survey altitude; air speed; photo-id altitude and number of passes per animal; measures to minimize disturbance.
- For **vessel surveys**, including with **photo-id**: Description (including latitude and longitude) of the survey area(s); time(s) of year for the surveys; type/size of survey vessel; vessel speed; protocols for going “off track” to photo-id animals, including type/size of photo-id vessel, vessel speed, number of close approaches per animal; measures to minimize disturbance.
- For **remote sampling** (biopsy) **in water**: type of vessel; vessel speed; minimum approach distance; number of close-approaches per animal; size and kind of biopsy dart; dart deployment method (e.g., cross bow, rifle, pole, etc.) including force of impact; maximum depth of dart penetration; location of sample on animal (i.e., shoulder, back, hindquarter, etc.); size of sample (diameter X depth); measures to minimize serious injury or mortality.
- For **remote sampling** (biopsy) **on land**: minimum approach distance, number of close-approaches per animal, size and kind of biopsy dart; dart deployment method (e.g., cross bow, rifle, pole, etc.) including force of impact; maximum depth of dart penetration; location of sample on animal (i.e., shoulder, back, hindquarter, etc.); size of sample (diameter X depth); measures to minimize serious injury or mortality.
- For **capture of pinnipeds**: describe capture method (i.e., underwater lasso, hoop net, floating trap, tranquilizer dart, beach seine, etc.); measures to minimize potential injury or mortality.
- For **chemical restraint of pinnipeds**: name of drug, dosage, route of administration (i.e., IV, IM, intubation, etc.); maximum duration of restraint; measures to minimize potential for injury or mortality; any reversal agents (include dosage, route).
- For **physical restraint of pinnipeds**: type of restraint (i.e., by hand, net, cage, etc.); maximum duration of restraint; measures to minimize potential injury or mortality.
- For **blood sampling of pinnipeds**: location of sample (which blood vessel); total volume needed for assay; total volume to be collected. For serial blood samples (e.g., for total body water or metabolic rate measurements) total number of samples per animal; sampling interval; total volume per sample.
- For **biopsy sampling of restrained pinnipeds**: type of tissue (i.e., skin only; skin with blubber; full blubber depth; muscle; etc.); location of sample on animal (i.e., shoulder, back, hindquarter, etc.); size of sample = diameter of sample X depth of sample; whether or not biopsy site would be left open or closed; if closed, manner of closure; biopsy tool (needle, punch, etc.); anesthetics or analgesics (include route and dosage).
- For **remote attachment of scientific instruments**: minimum approach distance; approach method (i.e., type of vessel, vessel speed, etc.); maximum number of close approaches per animal; deployment method (i.e., pole, cross bow, etc.); attachment method (i.e., suction cup, implantable); if implantable; depth of penetration and

composition of attachment device; maximum duration of attachment; method of removal/retrieval, if applicable; location of attachment on animal; type of instrument; mass and total external dimensions of instrument; if instrument emits signal, indicate frequency (λ) of signal in Hz, pulse rate and duration of signal.

- For **non-remote external attachment of scientific instruments** (i.e. to restrained animals): attachment method (e.g., epoxy, harness, flipper or fin tag, etc.); location of attachment on animal; type of instrument; mass and total external dimensions of instrument; if instrument emits signal, indicate frequency (Hz) and intensity (dB) of signal, pulse rate, and duration of signal; maximum duration of attachment; method of removal/retrieval, if applicable.
- For **internal instruments** (including PIT tags, heart rate monitors, stomach temperature pills, etc.): type of instrument; mass and dimensions of instrument; location of instrument; method of implant (e.g., injection, surgical, administered intra-esophageal into stomach). If surgical implant, describe surgical procedure including location and size of incision; method of incision closure; anticipated time for healing; duration of surgical procedure; use of anesthesia or sedatives.
- For **captive maintenance of mammals**: Explanation of how facilities and care meet AWA requirements.
- For **administering drugs or chemicals** in general: Dosage, route, reversal agents (where applicable); measures to minimize adverse effects, including mortality.
- For **auditory brainstem response or auditory evoked potential** (on captive or stranded marine mammals): handling protocol, type of measurement equipment, methods of data collection and data analysis. See also "Standard NMFS Questions for Permits Involving AEP."
- For **active acoustics** (playbacks or broadcasts): type of signal, depth in water column, power output, source level, frequency, maximum intended received level, signal duration and duty cycle. Inclusion of a propagation model is also desirable.

Attachment 1: Application Score Sheet

Protected Resources Permits Division
Initial Review of Marine Mammal Research or Enhancement Permit Application

File No. ________________ Applicant: __________________________

Rate how well the applicant's responses address each criterion, from 0 to 4 where:
(0) Not Applicable; (1) Not Addressed; (2) Poorly Addressed; (3) Adequately Addressed; or 4) Well Covered.

Use a "Summary of Application Review" memo to explain the rationale for ratings, as necessary.

	Statutory/ Regulatory Reference	Criterion	Application Reference	Rank	Weight	Score
General						
G1	50 CFR 216.33(a)	Used current version of application instructions	OMB No. 0648-0084		0	
G2	50 CFR 216.33(a)	Application signed by appropriate person (P.I. if individual applicant, or Responsible Party if institutional applicant)	VIII.		0	
G3	MMPA: 104(c)(1)	Activities proposed are for "purposes of scientific research" on marine mammals (MMPA)	IV.A & overall		0	
G4	ESA: 10(a)(1)(A)	Activities proposed are for "scientific purposes" (ESA)	IV.A & overall		0	
G5	MMPA; Sec.3 (12)(A)(i)	Species for which take is requested are under NMFS jurisdiction	IV.B.		0	
MMPA requirements						
M1	104(c)(3)(A)	Justification that taking of a marine mammal or marine mammal stock is necessary (i.e., applicant has demonstrated why hypothesis cannot be tested or question cannot be answered without taking a marine mammal)	Overall; and if depleted: IV.B.3.b(2)		0.20 (20%)	
	104(c)(3)(A)	Project is consistent with bona fide definition			(40%)	

	Statutory/ Regulatory Reference	Criterion	Application Reference	Rank	Weight	Score
M2		Clearly stated hypothesis to be tested, or question to be answered	IV.B.3.a		0.04 (4%)	
M3		Applicant has demonstrated that proposed methods are appropriate for hypothesis or objective	IV.C.2.		0.04 (4%)	
M4		Applicant has demonstrated that sample size is appropriate (neither too large nor too small) for hypothesis/question	IV.B.3.a.		0.04 (4%)	
M5		Sample size is achievable given applicant's resources and expertise of personnel	IV.E. & III.B.		0.03 (3%)	
M6		Applicant has demonstrated how the study would contribute to the basic knowledge of marine mammal biology or ecology, including relative importance of the contribution	IV.B.3.b		0.08 (8%)	
M7		Applicant has demonstrated how the study would identify, evaluate, or resolve conservation problems for marine mammals	IV.B.3.b		0.08 (8%)	
M8		Applicant has demonstrated that study is not unnecessarily duplicative	IV.B.2.a		0.03 (3%)	
M9		Applicant is reasonably likely to publish or otherwise make results available	IV.F. & attached CV per III.B.		0.06 (6%)	
	104(b)(2)(B)	Manner of taking is consistent with MMPA definition of humane			(20%)	
M10		Methods are described in sufficient detail to evaluate potential effects	IV.D.		0.04 (4%)	
M11		Applicant has appropriately identified potential effects, both short and long-term, of each	IV.D.a.		0.04 (4%)	

	Statutory/ Regulatory Reference	Criterion	Application Reference	Rank	Weight	Score
		procedure, as well as cumulative or synergistic effects				
M12		Alternatives search or description supports that proposed methods are those with least possible potential for pain, stress, etc.	IV.D.4		0.03 (3%)	
M13		Applicant has demonstrated why and how mitigation measures proposed would avoid or minimize adverse effects of each activity to the maximum extent practical	IV.D.2.		0.06 (6%)	
M14		Applicant has identified how proposed monitoring is appropriate to evaluate effects of research and recovery of animals post-handling or sampling	IV.D.3.		0.03 (3%)	
		Details of manner of taking			(10 %)	
M15	104(b)(2)(B)	Application describes the manner in which marine mammals will be taken	IV.C.2.b		0.04 (4%)	
M16	104(b)(2)(A)	Application specifies number and kind of animals proposed for taking, by species, stock, sex, age or life-history stage	IV.B.1.a		0.02 (2%)	
M17	104(b)(2)(B)	Application specifies the location for activity (with sufficient detail relative to evaluation of effects)	IV.C.1.b		0.02 (2%)	
M18	104(c)(3)(C)	Application specifies period during which activity would be conducted, including start and end date, with sufficient detail re: seasons, frequency, etc. to evaluate effects	IV.C.1.a		0.02 (2%)	
		Lethal Taking			(10%)	
M19	104(c)(3)(B)	If lethal taking (intentional	IV.C.4		0.04	

	Statutory/ Regulatory Reference	Criterion	Application Reference	Rank	Weight	Score
		or unintentional) is requested, applicant has justified that nonlethal methods are not feasible.			(4%)	
M20	104(c)(3)(B)	If lethal taking of depleted stock is requested, applicant has demonstrated how results of the research will directly benefit that species/stock or fulfill critically important research need	IV.C.4		0.04 (4%)	
M21		Applicant has appropriately identified and adequately explained mechanisms for research-related mortality and probability of such mortality	IV.D.1		0.02 (2%)	
					Total MMPA Score	
ESA requirements						
E1	10(d)	The permit has been "applied for in good faith:" i.e., the applicant has demonstrated their intent to act consistent with the requirements of the ESA, regulations, and permit conditions; and their capability is consistent with what they purport to accomplish	Past permit records (VI.A.) & III.B.		0.30 (30%)	
E2	10(d)	Applicant demonstrates that proposed activity "will not operate to disadvantage of listed species:" i.e., will not hinder recovery, result in harm that would put species at increased risk, or otherwise result in loss or damage that would delay recovery	IV.D		0.30 (30%)	
	10(d)	Would further a bona fide and necessary or desirable scientific purpose; or enhance propagation or survival			(40%)	
E3		Explains how research	IV.B.3.b(2)		0.10	

	Statutory/ Regulatory Reference	Criterion	Application Reference	Rank	Weight	Score
		results would directly benefit the species; contribute significantly to fulfilling critically important research need for the subject species; identify, evaluate, or resolve conservations problems for the subject species; or contribute significantly to understanding basic biology or ecology of subject species			(10%)	
E4		Applicant demonstrates knowledge of listing status and current population trends and threats	IV.B.1 and IV.B.2		0.05 (5%)	
E5		Applicant discusses possible adverse impacts of the proposed research and how they would be minimized or mitigated	IV.D.1 and IV.D.2		0.06 (6%)	
E6		Applicant and other personnel have appropriate prior experience with same or similar species and have demonstrated success with proposed or analogous methods	III.B		0.05 (5%)	
E7		Applicant has demonstrated why proposed research cannot be conducted using an alternative species or stock, not listed under ESA	IV.B.3.b(1)		0.06 (6%)	
E8		Applicant has provided appropriate documentation for captive born animals or has stated their intent to remove from the wild.	IV.C.3		0.04 (4%)	
E9		Applicant has described provisions for disposition of species at conclusion or project or program	IV.C.3(i)		0.04 (4%)	
					Total ESA Score	
Other applicable laws						

	Statutory/ Regulatory Reference	Criterion	Application Reference	Rank	Weight	Score
O1		Applicant has demonstrated compliance with IACUC requirements of their institution	IV.D.4.		0.01 (1%)	
O2		Applicant has demonstrated that they have applied for, secured, or will apply for other federal, state, and local permits required for conduct of the research	VI.B.		0.01 (1%)	
		NEPA determination			(8%)	
O3		Applicant has described location with sufficient detail for PR1 to evaluate potential environmental impacts	IV.C.1(b)		0.02 (2%)	
O4		Applicant has described methods with sufficient detail for PR1 to evaluate potential cumulative effects on target and non-target species and the physical environment	IV.C.2 and IV.C.3		0.02 (2%)	
O5		Applicant has identified all likely types of effects (short and long-term, direct and indirect, cumulative and synergistic) of the research	IV. D.1		0.02 (2%)	
O6		Applicant has described how their monitoring methods are appropriate for evaluating effects of their research	IV.D.3		0.02 (2%)	
					Total Other Laws Score	
					Total Application Score	

Analyst: ________________________ Date reviewed: __________________

Appendix E. Format for Annual and Final Permit Reports

Reports may be submitted
- through the online system at https://apps.nmfs.noaa.gov
- by email attachment to the permit analyst for this permit
- by hard copy mailed or faxed to the Chief, Permits Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Suite 13705, Silver Spring, MD 20910; phone (301) 713-2289; fax (301) 427-2521

Date: ______________________ **Reporting Period:** __________________________

Permit Number: _____________ **Permit Holder's Name:** ______________________________

Contact Name: ___________________ **Contact Email:** __________________________

Contact Phone #: __________________
(Contact = person submitting report)

Part I: Take Table. Enter the actual number of animals taken during this reporting period.

Insert take table from permit. Add column for "Actual number of animals taken".

NOTE: If you conducted activities or took protected species for which you were not authorized, you must enter them on separate lines of the table and explain exactly what happened (see Part II below).

Part II: **Narrative.** Briefly provide the following information:

1. Describe any problems or unforeseen effects encountered during the permitted activities and any steps taken or proposed to resolve such problems.

2. Describe what measures were taken to minimize effects of permitted activities on animals and the effectiveness of these measures.

3. If animals were unintentionally injured or killed, describe the circumstances. Describe how dead animals were disposed of if not in the way described in the permit.

4. Describe the physical condition of animals taken and used in the permitted activities.

5. Describe the effects permitted activities had on animals, including any unforeseen responses or effects.

6. Describe steps taken to coordinate the permitted activities with other permit holders.

7. Summarize any preliminary findings. Did you accomplish the goals of your permitted activities?

8. List titles of reports, publications, etc. resulting from this reporting period. Attach copies of any final documents as available. If these documents are not yet available, indicate when you anticipate that they will be completed and submitted. When reports and publications are available, send to the Permits Division, and include the permit number in the correspondence.

9. Note the number and type of non-permitted species caught, harassed, or otherwise taken, and the observed effects of such taking.

10. Note any incidental (non-research related) use of photographs, film, or other images (e.g., on websites, in commercial publications or documentaries).

11. Indicate any additional findings, results, or information on which you would like to report or comment.

Appendix D

Fritz et al. (2009) Memo on 2008 Non-Pup Steller Sea Lion Survey

United States Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service (NMFS)
Alaska Fisheries Science Center
National Marine Mammal Laboratory (NMML)
7600 Sand Point Way NE
Seattle WA 98115
206-526-4246 FAX: 206-526-6615
4 February 2009 F/AKC3:lwf

Memorandum For: North Pacific Fishery Management Council

From: Lowell Fritz, Tom Gelatt, John Bengtson, NMML
Douglas Demaster, AFSC

Subject: Survey of adult and juvenile Steller sea lions, June-July 2008: response to the Council's 19 December 2008 letter to Robert D. Mecum, Acting Administrator, NMFS Alaska Region

SUMMARY: This memorandum is in response to Council's request for more information on the 2008 aerial survey of Steller sea lions in Alaska and population trends since 2000. This request was made in a 19 December 2008 letter to Robert D. Mecum, Acting Administrator for NMFS Alaska Region. The Alaska Fisheries Science Center was asked by the Region to prepare a response to this letter.

An aerial survey to assess trends in numbers of adult and juvenile (non-pup) Steller sea lions (*Eumetopias jubatus*) in Alaska was conducted by NMFS from 7 June to 6 July 2008. We used a Twin Otter aircraft (operated by NOAA, Aircraft Operations Center, Tampa FL) equipped with a vertically-oriented, high resolution digital camera (with forward motion compensation) mounted in the plane's belly port to survey Steller sea lions on terrestrial rookery and haul-out sites from southeast Alaska through the Aleutian Islands. This was the first complete survey of the endangered western distinct population segment (DPS) in Alaska since 2004 (Fritz et al. 2008), and the first complete survey of the threatened eastern DPS in southeast Alaska since 2002 (Pitcher et al. 2007).

Trends in counts of adult and juvenile western Steller sea lions (wSSLs) in Alaska from 2000 to 2008 have not been consistent across the range nor for the entire period:

- During the first four years (2000-2004), Alaska wSSL non-pup counts increased 11%. Most of the 2000-2004 increase occurred in the core region from the Kenai Peninsula through Kiska Island (Kenai-Kiska); decreases west of the Kenai-Kiska region (western Aleutian Islands) were largely balanced by increases to the east (eastern Gulf of Alaska).
- During the second four years (2004-2008), Alaska wSSL non-pup counts increased 3% due to greater numbers counted in the eastern Gulf of Alaska. Kenai-Kiska counts were stable, but counts in the western Aleutian Islands continued to decline. Evidence suggests that movement of animals from southeast Alaska (eastern DPS) to haul-outs in the eastern Gulf of Alaska

(western DPS) prior to the 2008 survey contributed to higher counts in the eastern Gulf of Alaska and lower than expected counts in southeast Alaska. We do not have a precise estimate of the number of eastern DPS animals counted in the eastern Gulf of Alaska. However, if it as high as 1,000 (the approximate increase observed between 2004 and 2008 at a single eastern Gulf of Alaska haul-out, Cape St. Elias), then Alaska wSSL non-pup counts would have declined 1% between 2004 and 2008. As a consequence, we conclude that the recent (2004-2008) trend for adult and juvenile western Steller sea lions in Alaska is stable or declining slightly.

Pup production by Steller sea lions in the western DPS in Alaska has been largely stable between 1998 and 2005/07, despite overall increases in non-pup counts between 2000 and 2008. Throughout the western DPS in Alaska, pup counts declined 2% overall in this 7-9 year period, increased 4% in the eastern Gulf of Alaska and increased about 3% in the Kenai-Kiska core. Changes in non-pup counts since 2000 in the eastern Gulf of Alaska (+93%) were far greater than increases in pup counts in the last 8 or 4 years in the eastern Gulf itself (+4% or +22%, respectively) or the entire western DPS in Alaska (-2% or +4%, respectively). This supports the hypothesis that the large increase in non-pups in the eastern Gulf of Alaska is not due to local pup production but more likely a result of seasonal movements of animals from the population in southeast Alaska that has been consistently increasing since the late 1970s.

METHODS

2008 Survey of Non-pups in Alaska

Aerial surveys for non-pups are conducted in June, when the greatest proportion of adults is onshore to give birth and breed. The primary objective in 2008 was to survey all terrestrial rookery and haul-out sites within the range of the Steller sea lion in Alaska from Dixon Entrance in southeast Alaska (134°W) to Attu Island (172°E) at the western end of the Aleutian Islands (Figure 1); the single rookery (Walrus Island) and 9 haul-outs in the eastern Bering Sea region north of the Alaska Peninsula were not surveyed. In 2008, we successfully assessed sea lion numbers at 339 of the 356 (95%) known terrestrial rookery and haul-out sites in the survey region. Of the 339 sites successfully surveyed, 169 were photographed, 30 had so few sea lions (< 15) that they were counted visually by observers on the plane, and 140 had no sea lions. Of the 17 ‘missed’ sites, 15 could not be surveyed because of poor weather conditions, while 2 (rookeries on Chowiet and Chirikof Islands) were incompletely surveyed.

In 2008, we began the survey in southeast Alaska, basing operations in Sitka, and surveyed the entire southeast area on 7-8 June. In the past, southeast Alaska surveys were usually conducted after the western DPS survey was completed, and as a consequence, have generally been conducted in late June or early July. The most recent survey of southeast Alaska sea lions was conducted on 4-5 July 2002, or approximately 1 month earlier in the year than in 2008. All other Steller sea lion surveys conducted in southeast Alaska since 1996 were done on or after 20 June, or about 2 weeks later than the 2008 survey. Prior to 2008, the next earliest-in-the-year southeast Alaska survey was conducted on 12-13 June 1994. In 2008, we began the western DPS survey in the Prince William Sound area on the same day (9 June) as the non-pup survey conducted in 2007.

Trend Analysis

NMML monitors the Steller sea lion population by surveying and counting animals at trend sites which have been consistently surveyed since the mid-1970s (N=85 1970s trend sites in the range of the western DPS in Alaska; N=19 in southeast Alaska including each of the sites that comprise the Forrester complex) or 1991 (N=161 1990s trend sites in the range of the western DPS in Alaska). In the rest of this report, only counts at 1990s trend sites are discussed, and these will be referred to simply as 'trend sites'. The vast majority (> 90%) of all sea lions counted during surveys conducted since 2004 have been counted at trend sites. All trend sites in southeast Alaska (eastern DPS) and all but 5 of the 161 trend sites in the range of the western DPS were surveyed in 2008; of these, 3 could not be surveyed from the air because of bad weather (two rookeries on Ugamak Island and a haul-out located at East Cape on Amchitka Island), while 2 (rookeries on Chowiet and Chirikof Islands) were incompletely surveyed. For trend analyses, 2008 counts at these five sites were estimated using data from previous (2006 or 2007) aerial surveys or were obtained from land-based observers in 2008. (For details regarding the estimation and counting procedures for trend sites missed in non-pup surveys conducted in 2006-2008, see Memorandum to the Record, Fritz et al., 17 November 2008, NMFS, AFSC, NMML, http://www.afsc.noaa.gov/nmml/pdf/SSLNon-Pups2008memo.pdf).

Surveys conducted prior to 2004 used oblique 35 mm photography. Differences in resolution between oblique 35 mm and vertical high resolution photographs requires an adjustment factor of -3.64% be applied to all counts from vertical photographs in order to properly analyze regional time series that include counts from years prior to 2004 (Fritz and Stinchcomb 2005).

Analysis of Survey Timing in Southeast Alaska and E GULF on Non-Pup Counts

Because the 2008 survey dates in southeast Alaska were earlier than in other years, we analyzed the effect that day of the year may have had on counts in the southeast Alaska and eastern Gulf of Alaska (E GULF) regions. We used generalized linear models and estimating equations (SAS procedure GENMOD; SAS 2002) to *a posteriori* analyze counts of adult and juvenile sea lions in 10 clusters of rookeries and haul-outs in both regions (Figure 2; for details regarding the analysis of movement between southeast Alaska and the E GULF, see Memorandum to the Record, Fritz et al., 17 November 2008, NMFS, AFSC, NMML, http://www.afsc.noaa.gov/nmml/pdf/SSLNon-Pups2008memo.pdf).

RESULTS AND DISCUSSION

Counts of adult and juvenile Steller sea lions at trend sites within the range of the western DPS in Alaska in 2000-2008 are listed in Table 1. Counts at all sites in southeast Alaska within the range of the eastern DPS from surveys in 2002 and 2008 are shown in Table 2.

Non-Pup Trends in the Western DPS in Alaska

Counts of adult and juvenile Steller sea lions at all trend sites within the range of the western DPS in Alaska increased 14% between 2000 and 2008, and most of this increase occurred in the first four years (11% increase between 2000 and 2004; Table 3 and Figure 3). In the core of the western DPS range in Alaska (Kenai-Kiska), all of the 2000-2008 increase of 10% occurred between 2000 and 2004. In the larger Kenai-Attu region, counts increased 7% in the first four years, but then dropped slightly between 2004 and 2008. Consequently, the overall increase of 3% observed between 2004 and 2008 in the western DPS in Alaska was due entirely to a 35% higher count in the E GULF (Table 3).

Non-Pup Trends by Region within the Western DPS in Alaska

There has been considerable variation between regions and periods (2000-2004 and 2004-2008) in non-pup count trends (Tables 3 and 4; Figures 4 and 5):

- Regions that increased between 2000 and 2008: eastern Aleutian Islands (E ALEU), western Gulf of Alaska (W GULF) and E GULF
    - The E ALEU was the only region where non-pup counts increased throughout 2000-2008, though more in the first half than the second.
    - While counts in the W GULF increased overall from 2000 to 2008, data from the incomplete 2007 survey (Tables 1 and 4) indicated that all of the increase occurred between 2000 and 2007, and counts declined slightly between 2007 and 2008.
    - Non-pup counts increased steadily in the E GULF between 2000 and 2006, dropped slightly in 2007, and then increased substantially (+47%) in 2008. We counted 1,090 more non-pups on E GULF trend sites in 2008 than in 2004 (Table 1), and 1,082 of these were at the easternmost haul-out in the range of the western DPS, Cape St. Elias.

- Regions that decreased between 2000 and 2008: western Aleutian Islands (W ALEU), central Aleutian Islands (C ALEU), and the central Gulf of Alaska (C GULF)
    - The W ALEU was the only region where non-pup counts declined throughout 2000-2008, and the decline was steeper in the second half than the first.
    - While the C ALEU decreased 11% overall from 2000 to 2008, non-pup counts increased 5% from 2000 to 2004 but then dropped 16% from 2004-2008 (Table 3). Within the C ALEU, there were different trends in the western than eastern halves of this region. In the C ALEU-W, counts dropped continuously between 2000 and 2008: -8% in the first half and -13% in the second (Table

4). By contrast, counts increased 15% in the C ALEU-E from 2000-2004, but then declined 17% in the next four years (Table 4).[1]

- o While the C GULF decreased slightly (-3%) overall from 2000 to 2008, non-pup counts decreased 12% in the first four years and increased 10% in the second (Table 3; Figures 4 and 5). There was variability in the second four year pattern with an increase of 17% between 2004 and 2007 followed by a decline of 6% between 2007 and 2008 (Table 4).

Analysis of 2000-2008 trends in more detail (Table 4) reveals:

- The W GULF, E ALEU and C ALEU-E regions all increased substantially (+15-33%) during the first four years. During the second four years, increases continued but at a much slower rate in the W GULF and E ALEU, while counts dropped in the C ALEU-E.
- To the west in the C ALEU-W and W ALEU, counts dropped continuously,
- To the east in the C GULF, counts varied by year but overall dropped only slightly, and
- In the easternmost region (E GULF), counts increased substantially overall.

These trends indicate that the non-pup Steller sea lion population in the core of the range of the western DPS in Alaska (Kenai – Kiska) increased between 2000 and 2004, but has been stable overall between 2004 and 2008. Outside of this core, the W ALEU declined substantially while counts in the E GULF almost doubled.

Pup Production Trends Overall and by Region within the Western DPS in Alaska

Regional total counts of Steller sea lion pups at trend rookeries within the range of the western DPS in Alaska from 1978-2007 are listed in Table 5 (this table is from Fritz et al. 2008; see this publication for other information regarding pup counts). Changes in pup counts between both 1998 and 2005-07, and between 2001-02 and 2005-07 are shown in Table 5. The earlier, longer period for pup counts (1998-2005/07) is discussed below with respect to 2000-2008 non-pup counts because these data indicate trends at an earlier life stage.

Pup production by Steller sea lions in the western DPS in Alaska was stable between 1998 and 2005/07, despite overall increases in non-pup counts between 2000 and 2008. Throughout the western DPS, pup counts declined 2% overall in this 7-9 year period, while in the Kenai-Kiska core, counts increased about 3%. By contrast, non-pup counts increased 14% and 10% between 2000 and 2008 in the two ranges, respectively (Figure 6).

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[1] Surveys conducted in the C ALEU in 2008 preceded the 7 August eruption of the volcano on Kasotochi Island, which greatly altered the physical structure of the island and deposited a thick layer of gravel, boulders and ash on the rookery area. The fate of the approximately 350 pups and 550 non-pups counted on the rookery on 21 June (approximately 6 weeks before the eruption) is not known. However, on 28 August, US Fish and Wildlife Service scientists observed approximately 250 non-pups and 2 pups on the southwest side of the island (J. Williams, USFWS, personal communication).

In the W ALEU and C GULF, both non-pup and pup counts decreased, but pup counts decreased faster. In the C ALEU, pups and non-pups declined at about the same rate (Figure 6).

In regions where non-pup counts increased overall (E ALEU, W GULF, E GULF and Kenai-Kiska), pup production also increased but at slower rates in all regions except the E ALEU. However, in the E GULF, there is a marked difference in these rates, with non-pup counts increasing 93% while pup counts increased only 4% (though 22% between 2001-02 and 2005-07); the other increasing regions had much smaller differences between rates of non-pup and pup increases (Figure 6). We conclude that it is unlikely that the large increase in non-pup counts observed in the E GULF between 2000 and 2008 is solely the result of pup production in either the E GULF or neighboring C GULF regions. By contrast, pup production increased at 3.2% between 1979 and 2005 at rookeries in southeast Alaska (Pitcher et al. 2007); movement of animals from this increasing population to the E GULF likely contributed to the recent increases in the latter region.

Movement of Non-Pups between Southeast Alaska and the E GULF

Increases in non-pups in the E GULF between 2000 and 2008 occurred more at haul-outs than at rookeries (Figure 7). In particular, increases were greater on the easternmost haul-outs in the E GULF (e.g., Cape St. Elias and Cape Hinchinbrook) or in northern Prince William Sound (e.g., Glacier) than they were on haul-outs in southwestern Prince William Sound or in western portions of the E GULF (e.g., The Needle, Point Elrington, Seal Rocks (Kenai)). Where increases did occur, there has also been considerable inter-annual variability (Table 1).

The following observations:

- a substantial increase in non-pups in the E GULF,
- relatively stable pup production in the E GULF and C GULF,
- increasing pup production in southeast Alaska, at least through 2005, and
- greater increases (and high variability) in non-pup counts at eastern E GULF haul-outs than at western E GULF haul-outs or rookeries,

are consistent with the hypothesis that some fraction of the non-pups counted in the E GULF region in the last several surveys (particularly those from 2004-2008) are eastern DPS animals that were foraging in the northern Gulf of Alaska in late spring (through early June). If this hypothesis is true, we should count more sea lions in early June in the E GULF, particularly at the easternmost sites, and count fewer in late June-early July; in southeast Alaska, we should observe the opposite pattern: lower counts early and higher counts late. Total counts at southeast Alaska trend sites in 2002 and 2008 generally support this hypothesis (Table 2; Figure 8). The survey in 2002 was conducted ‘late’ (in early July), and resulted in a total count of 15,284 non-pups with 9,989 on trend sites. By contrast, the survey in 2008 was conducted ‘early’ (in early June), and 939 fewer non-pups were counted on all sites and 1,201 fewer on trend sites. There is no evidence to suggest that the southeast Alaska sea lion population declined between 2002 and 2008 (Pitcher et al. 2007; NMFS 2008). Instead, it may be the timing of the surveys in these two regions in 2008 compared to previous years that gives the appearance of a decline in southeast Alaska and contributes to the apparent increase in the E GULF.

Results of analyses of E GULF and southeast Alaska non-pup counts from 1990-2008 using generalized linear models, though not statistically significant, generally support the proposed hypothesis of regional movement between the E GULF and southeast Alaska in June (Figures 2 and 9). Only at the easternmost E GULF haul-outs (cluster 1) does the model estimate higher counts early in the survey period (early June) than later (late June or early July; Figure 9C). At the western E GULF haul-outs (clusters 2-4), estimated counts late in the survey period were slightly higher than those early (Figure 9A), but the slope here was much smaller than that estimated for the southeast Alaska haul-outs (clusters 6-9; Figure 9D). Slightly increasing estimated counts at rookeries (clusters 5 and 10) during the survey period are not unexpected since adult females would be arriving at these locations to give birth and breed. These patterns of non-pup counts at haul-outs in the E GULF and southeast Alaska in June through early July are consistent with, but do not prove, the regional movement hypothesis.

In 2008, then, we may have counted animals on the four easternmost sites in the E GULF (surveyed 'early') that 'should' have been counted as part of the eastern DPS. Over 85% of the non-pups counted on Cape St. Elias and Cape Hinchinbrook during the 2006-2008 surveys (all of which were conducted 'early' prior to 14 June) were juveniles or adult females, the most likely age-sex classes to make such movements at this time. Based on the magnitude of the 'decline' in southeast Alaska between 2002 and 2008, and the 'increase' in the E GULF between 2004 and 2008, the number of non-pups that moved from southeast Alaska to the E GULF early in the survey period may be as high as 1,000. At this time, however, we have no precise estimate of the number of eastern DPS animals from southeast Alaska that were counted on haul-outs or rookeries early in the survey period in the E GULF. However, if it as high as 1,000 (the approximate increase observed between 2004 and 2008 at Cape St. Elias alone), then 'true' Alaska wSSL non-pup counts would have declined -1% between 2004 and 2008.

In 2009, we plan on conducting a 'late' survey in the southeast Alaska and E GULF regions as part of the Alaska-wide sea lion pup assessment. If our movement hypothesis is correct, we expect to see lower non-pup counts overall in the E GULF, and on haul-outs in particular, and higher overall in SEAK than we did in 2008.

CONCLUSION

Trends in counts of adult and juvenile western Steller sea lions (wSSLs) in Alaska from 2000 to 2008 have not been consistent across the range nor for the entire period:

- During the first four years (2000-2004), Alaska wSSL non-pup counts increased by 11%. Most of the 2000-2004 increase occurred in the core region from the Kenai Peninsula through Kiska Island (Kenai-Kiska); decreases in the W ALEU were largely balanced by increases in the E GULF.
- During the second four years (2004-2008), Alaska wSSL non-pup counts increased by 3% due to greater numbers counted in the E GULF. Kenai-Kiska

counts were stable, but counts in the W ALEU continued to decline. Evidence suggests that movement of animals from southeast Alaska (eastern DPS) to haul-outs in the E GULF (western DPS) prior to the 2008 survey contributed to higher counts in the E GULF and lower than expected counts in southeast Alaska. We do not have a precise estimate of the number of eastern DPS animals counted in the E GULF. However, if it as high as 1,000 (the approximate increase observed between 2004 and 2008 at a single E GULF haul-out, Cape St. Elias), then Alaska wSSL non-pup counts would have declined -1% between 2004 and 2008. As a consequence, we conclude that the recent (2004-2008) trend for adult and juvenile western Steller sea lions in Alaska is stable or declining slightly.

Pup production by Steller sea lions in the western DPS in Alaska has been largely stable between 1998 and 2005/07, despite overall increases in non-pup counts between 2000 and 2008. Throughout the western DPS in Alaska, pup counts declined 2% overall in this 7-9 year period, increased 4% in the E GULF and increased about 3% in the Kenai-Kiska core. Increases in non-pup counts since 2000 in the E GULF (+93%) were far greater than increases in pup counts in the last 8 or 4 years in the E GULF itself (+4% or +22%, respectively) or the entire western DPS in Alaska (-2% or +4%, respectively). This supports the hypothesis that the large increase in non-pups in the eastern Gulf of Alaska is not due to local pup production but more likely a result of seasonal movements of animals from the population in southeast Alaska that has been consistently increasing since the late 1970s.

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Table 1. Counts of adult and juvenile (non-pup) Steller sea lions at trend rookeries and haul-outs in the range of the western distinct population segment (DPS) in Alaska from aerial surveys conducted in June-July 2000-2008. In 2000 and 2002, sea lions were counted off oblique 35 mm film images; in 2004-2008, sea lions were counted off high resolution vertical images. **This table contains raw unadjusted counts. For trend analysis, region totals from 2004-2008 must be multiplied by 96.36% to account for differences in counts due to photo orientation and resolution (Fritz and Stinchcomb 2005).** Rookeries labeled Y* are 'new' rookeries: they have produced at least 50 pups since 1975, but were not included as rookeries in the designation of critical habitat (CH) in 1993. Rookeries labeled N* are CH rookeries, but have not produced at least 50 pups since 1975.

SITENAME	REGION	Rookery	2000	2002	2004	2006	2007	2008
CAPE ST. ELIAS	E GULF		485	574	318	414	728	1,400
CAPE HINCHINBROOK	E GULF		106	107	496	237	95	229
SEAL ROCKS	E GULF	Y	749	768	841	1,119	803	1,024
WOODED (FISH)	E GULF	Y	396	396	523	619	282	603
GLACIER	E GULF		0	435	620	466	531	509
THE NEEDLE	E GULF		126	115	123	127	145	88
POINT ELRINGTON	E GULF		128	114	132	58	37	169
CAPE PUGET	E GULF		0	0	0	0	0	0
CAPE FAIRFIELD	E GULF		21	2	0	0	10	47
RUGGED	E GULF		3	0	0	0	0	8
AIALIK CAPE	E GULF		0	6	1	103	161	77
CHISWELL ISLANDS	E GULF	Y*	54	97	72	71	74	68
SEAL ROCKS (KENAI)	E GULF		34	1	3	4	2	0
OUTER (PYE)	C GULF	Y	262	226	222	251	268	249
GORE POINT	C GULF		0	0	0	0	0	0
EAST CHUGACH	C GULF		0	0	0		0	0
PERL	C GULF		48	99	49		241	144
NAGAHUT ROCKS	C GULF		10	1	1		2	21
ELIZABETH/CAPE ELIZABETH	C GULF		78	177	28		0	0
SUGARLOAF	C GULF	Y	706	736	667	733	662	849
USHAGAT/NW	C GULF		1	1	3	0	0	0
USHAGAT/SW	C GULF	Y*	98	116	101	141	74	96
USHAGAT/ROCKS SOUTH	C GULF		37	5	8	9	0	45
LATAX ROCKS	C GULF		100	145	56		115	108
SEA OTTER	C GULF		118	45	127		100	1
RK NEAR SEA OTTER	C GULF		0	0	10		0	47
AFOGNAK/TONKI CAPE	C GULF		1	0	0		0	16
SEA LION ROCKS (MARMOT)	C GULF		56	0	2		1	13
MARMOT	C GULF	Y	671	848	703	686	551	644
LONG ISLAND	C GULF		36	80	32			59
KODIAK/CAPE CHINIAK	C GULF		165	102	87		241	130
UGAK	C GULF		0	0	0		0	0
KODIAK/GULL POINT	C GULF		106	99	109		148	109
KODIAK/CAPE BARNABAS	C GULF		0	0	0		140	84

Table 1 (continued)

SITENAME	REGION	Rookery	2000	2002	2004	2006	2007	2008
TWOHEADED	C GULF		254	227	266		228	204
SITKINAK/CAPE SITKINAK	C GULF		160	91	80		104	115
KODIAK/CAPE UGAT	C GULF		182	104	2	167	248	285
KODIAK/STEEP CAPE	C GULF		0	28	0	14	61	38
SHAKUN ROCKS	C GULF		225	45	104	67	113	81
TAKLI	C GULF		33	79	85	157	92	67
PUALE BAY	C GULF		84	94	58	2	1	2
UGAIUSHAK	C GULF		2	2	0	0	2	0
SUTWIK	C GULF		114	114	206	114	127	93
CHOWIET	C GULF	Y	504	582	541		576	559
CHIRIKOF	C GULF	Y	276	320	303		300	300
NAGAI ROCKS	C GULF		228	231	330		449	234
CHERNABURA	W GULF	Y	496	496	828		1,228	1,281
LIGHTHOUSE ROCKS	W GULF	Y*	64	84	111	153	152	164
KAK	W GULF		70	108	17	24		1
MITROFANIA	W GULF		126	150	182	103	116	129
SPITZ	W GULF		6	0	1	0	11	1
KUPREANOF POINT	W GULF		12	64	53	116	53	72
CASTLE ROCK	W GULF		38	75	70	15	38	28
ATKINS	W GULF	Y	537	560	651	663	585	558
THE HAYSTACKS	W GULF		62	50	38	1	41	3
THE WHALEBACK	W GULF		162	116	102	99	83	102
NAGAI/MOUNTAIN POINT	W GULF		62	105	80	56	148	60
SEA LION ROCKS (SHUMAGINS)	W GULF		33	26	36	142	44	54
UNGA/ACHEREDIN POINT	W GULF		108	188	264	152	229	202
JUDE	W GULF	Y*	391	374	474	338	445	465
PINNACLE ROCK	W GULF	Y	868	1,034	1,011	1,167	1,057	1,094
CLUBBING ROCKS	W GULF	Y	712	830	911	1,037	1,063	952
CHERNI	W GULF		0	0	0	0	0	0
SOUTH ROCKS	W GULF		161	262	528	320	457	451
BIRD	W GULF		88	95	57	62	97	155
ROCK	W GULF		0	0	17	0	0	0
UNIMAK/CAPE SARICHEF	E ALEU		216	321	250	6	0	167
AMAK+ROCKS	E ALEU		946	563	733	410	220	265
SEA LION ROCK (AMAK)	E ALEU	Y	258	507	456	447	385	360
UGAMAK COMPLEX	E ALEU	Y	746	1,044	1,304	1,319	1,493	1,619
AIKTAK	E ALEU		92	75	101	111	43	42
TIGALDA/ROCKS NE	E ALEU		123	134	141	202	236	359
TIGALDA/SOUTH SIDE	E ALEU		42	38	46	83	105	91
ROOTOK	E ALEU		93	84	96	96	141	60
TANGINAK	E ALEU		8	3	4	6	4	1
AKUN/BILLINGS HEAD	E ALEU	Y	254	275	307	338	523	386
AKUTAN/REEF-LAVA	E ALEU		43	36	119	103	57	128
AKUTAN/CAPE MORGAN	E ALEU	Y	739	783	1,021	1,249	1,172	1,135
OLD MAN ROCKS	E ALEU		114	25	71	112	81	89
EGG	E ALEU		0	1	5	0	0	0
OUTER SIGNAL	E ALEU		2	0	0	0	0	10

Table 1 (continued)

SITENAME	REGION	Rookery	2000	2002	2004	2006	2007	2008
UNALASKA/CAPE SEDANKA	E ALEU		0	106	0	0	0	0
UNALASKA/BISHOP POINT	E ALEU		106	122	265	285	196	204
UNALASKA/MAKUSHIN BAY	E ALEU		79	7	20	88	154	115
UNALASKA/SPRAY CAPE	E ALEU		0	67	0	0	0	0
UNALASKA/CAPE IZIGAN	E ALEU		116	211	238	329	304	188
BOGOSLOF/FIRE ISLAND	E ALEU	Y	347	357	380	358	405	390
UMNAK/CAPE ASLIK	E ALEU		74	52	119	73		63
POLIVNOI ROCK	E ALEU		108	98	91	42	96	93
THE PILLARS	E ALEU		51	14	4	0	0	0
OGCHUL	E ALEU	Y	117	105	139	132	152	200
VSEVIDOF	E ALEU		46	34	48	41	35	50
ADUGAK	E ALEU	Y	270	201	259	429	473	636
ULIAGA	C ALEU		90	121	0	99		66
KAGAMIL	C ALEU		24	12	1	0		0
CHUGINADAK	C ALEU		23	62	129	79		53
CARLISLE	C ALEU		12	0	0	0		27
HERBERT	C ALEU		6	2	38	66		105
YUNASKA	C ALEU	Y	241	276	260	255	279	282
CHAGULAK	C ALEU		40	5	0	13		59
AMUKTA+ROCKS	C ALEU		38	42	2	18	56	35
SEGUAM/FINCH POINT	C ALEU		14	27	2		0	0
SEGUAM/SW RIP	C ALEU		23	50	40		31	39
SEGUAM/SADDLERIDGE	C ALEU	Y	570	666	923		668	835
SEGUAM/TURF POINT	C ALEU		82	84	58		8	3
SEGUAM/LAVA COVE	C ALEU		0	0	0		0	0
SEGUAM/LAVA POINT	C ALEU		0	10	5		0	0
SEGUAM/WHARF POINT	C ALEU		55	50	90		121	49
AGLIGADAK	C ALEU	N*	48	82	61		15	14
AMLIA/EAST CAPE	C ALEU		86	82	34		55	117
AMLIA/SVIECH. HARBOR	C ALEU		120	98	144		113	100
TANADAK (AMLIA)	C ALEU		74	32	1		0	30
SAGIGIK	C ALEU		22	40	30		10	14
ATKA/NORTH CAPE	C ALEU		76	224	383	279	140	32
ATKA/CAPE KOROVIN	C ALEU		12	1	4	0	30	39
SALT	C ALEU		0	0	0		0	4
KASATOCHI/NORTH POINT	C ALEU	Y	390	529	667	610	613	550
OGLODAK	C ALEU		66	76	86	111	58	99
IKIGINAK	C ALEU		0	8	0	8	16	0
FENIMORE	C ALEU		67	22	30	10	9	4
ANAGAKSIK	C ALEU		46	40	2	52	14	20
GREAT SITKIN	C ALEU		29	106	0	0	0	0
LITTLE TANAGA STRAIT	C ALEU		234	82	49		15	36
KAGALASKA	C ALEU		45	34	48	0	3	42
ADAK	C ALEU	Y	874	821	1,008		779	621
KANAGA/N CAPE	C ALEU		25	12	7	13	2	14
KANAGA/CAPE MIGA	C ALEU		1	0	0	0	0	0
KANAGA/SHIP ROCK	C ALEU	Y*	156	242	229		331	322

Table 1 (continued)

SITENAME	REGION	Rookery	2000	2002	2004	2006	2007	2008
TANAGA/BUMPY POINT	C ALEU		18	26	33		33	22
TANAGA/CAPE SASMIK	C ALEU		154	148	122		63	95
GRAMP ROCK	C ALEU	Y	580	600	679			593
UGIDAK	C ALEU		6	23	25			16
TAG	C ALEU	Y	301	279	242			255
KAVALGA	C ALEU		50	18	56			63
UNALGA+DINKUM ROCKS	C ALEU		50	46	19			0
ULAK/HASGOX POINT	C ALEU	Y	663	481	531			537
AMATIGNAK/KNOB POINT	C ALEU		0	0	1		0	3
AMATIGNAK/NITROF POINT	C ALEU		96	40	76	38		49
SEMISOPOCHNOI/POCHNOI	C ALEU	N*	65	70	55	41		32
AMCHITKA/CAPE IVAKIN	C ALEU		0	0	0	0	0	0
AMCHITKA/EAST CAPE	C ALEU	N*	101	186	178	103		103
AMCHITKA/ST. MAKARIUS	C ALEU		0	0	0	0	0	0
AMCHITKA/COLUMN ROCK	C ALEU	Y	92	71	85			71
AYUGADAK	C ALEU	Y	146	182	152			152
RAT	C ALEU		2	28	45			0
SEA LION ROCK (KISKA)	C ALEU		0	1	0			0
TANADAK (KISKA)	C ALEU		71	54	34			1
KISKA/SOBAKA-VEGA	C ALEU		152	54	101			52
KISKA/CAPE ST STEPHEN	C ALEU	Y	152	126	210		211	229
KISKA/LIEF COVE	C ALEU	Y	272	174	170		164	162
KISKA/PILLAR ROCK	C ALEU		0	3	0			0
BULDIR	W ALEU	Y	129	94	108			43
SHEMYA	W ALEU		54	34	17	18		4
ALAID	W ALEU		156	158	125	86		86
AGATTU/CAPE SABAK	W ALEU	Y	480	307	325	282	203	202
AGATTU/GILLON POINT	W ALEU	Y	306	258	374	308		281
ATTU/MASSACRE BAY	W ALEU		0	0	0	0		0
ATTU/CHIRIKOF POINT	W ALEU		145	19	75	30		42
ATTU/CHICHAGOF POINT	W ALEU		52	62	54	13		25
ATTU/KRESTA POINT	W ALEU		1	0	0	0		0
ATTU/CAPE WRANGELL	W ALEU	Y	310	264	257	260		247

Table 2. Counts of adult and juvenile (non-pup) Steller sea lions at trend (Y) and non-trend haul-outs and rookeries (Y) from high resolution aerial photographs taken in July 2002 and June 2008 in southeast Alaska. Counts from trend sites labeled Y* were omitted from the 'Total Trend Sites' since these sites were missed in 2002. The Brothers count is the sum of counts from The Brothers/SW and The Brothers/NW.

SITENAME	TREND	ROOKERY	2002	2008
LITTLE ISLAND				0
POINT MARSH			104	4
WEST ROCK			640	841
WOLF ROCK			207	300
SAKIE POINT				0
CAPE BARTOLOME			41	0
CAPE ADDINGTON			1074	718
GRINDALL			130	374
TIMBERED			442	288
HAZY	Y	Y	2,050	1,686
EASTERLY				255
CORONATION	Y		46	279
South of Cape Ommaney				102
CAPE OMMANEY			344	117
LARCH BAY				28
SEA LION ROCK (PUFFIN BAY)			264	0
ETOLIN				0
PATTERSON POINT				0
BIALI ROCK	Y	Y	626	408
FORRESTER COMPLEX	Y	Y	3,699	2,894
JACOB ROCK	Y		203	101
KAIUCHALI (BIORKA)			46	31
HORN CLIFF				0
YASHA			920	379
ST. LAZARIA				0
PINTA ROCKS				0
TURNABOUT	Y*			0
ROUND ROCK				0
THE BROTHERS	Y		981	765
SEA LION ISLANDS	Y*			137
POINT LULL				153
SAIL			0	3
FALSE POINT PYBUS			0	0
SUNSET			348	384
POINT LEAGUE (STEVENS PASSAGE)			0	1
WHITE SISTERS	Y	Y	1,156	1,132
TENAKEE CANNERY POINT				0

Table 2 (Continued)

SITENAME	TREND	ROOKERY	2002	2008
CAPE CROSS	Y		1	1
MIST				0
POINT MARSDEN				0
CAPE BINGHAM			0	0
CIRCLE POINT				0
THE SISTERS				0
DOROTHY				0
GRAVES ROCK	Y	Y	1,001	1,305
INIAN			206	116
VENISA			0	0
POINT CAROLUS			0	0
BENJAMIN			0	0
HARBOR POINT	Y		186	178
SOUTH MARBLE			238	786
CASE (TLINGIT) POINT				0
CAPE FAIRWEATHER	Y*			0
MET POINT				0
ELDRED ROCK				0
GRAN (LEDGE) POINT			331	583
Total Trend Sites			**9,949**	**8,748**
Total Other Sites			**5,335**	**5,597**

Table 3. Counts of adult and juvenile (non-pup) Steller sea lions observed at rookery and haul-out trend sites in eight sub-areas of Alaska during June-July aerial surveys from 1991 to 2008. Overall percentage changes between various pairs of years are also shown. * For eastern Gulf of Alaska in 1998, counts made in 1999 were substituted for those sites not surveyed in 1998. Subarea count totals for 2004-2008 (**) have been adjusted to account for film format-count differences. Kenai-Kiska is comprised of the central and western Gulf of Alaska and eastern and central Aleutian Islands sub-areas. Kenai-Attu is comprised of the Kenai-Kiska plus the western Aleutian Islands sub-areas.

	Gulf of Alaska			**Aleutian Islands**					**Western Stock**
Year	**Eastern**	**Central**	**Western**	**Eastern**	**Central**	**Western**	**Kenai-Kiska**	**Kenai-Attu**	**In Alaska**
1991	4,812	7,872	5,338	5,283	8,656	4,601	27,149	31,750	36,562
1992	3,981	7,358	5,112	5,707	7,633	4,199	25,811	30,010	33,991
1994	3,612	6,505	5,718	5,664	6,909	3,114	24,796	27,910	31,522
1996	2,450	5,400	5,356	5,967	6,368	3,334	23,091	26,425	28,875
1998*	2,158	4,806	5,367	5,774	7,017	2,786	22,964	25,750	27,908
2000	2,102	4,555	3,996	4,990	6,560	1,633	20,101	21,734	23,836
2002	2,615	4,594	4,617	5,261	6,547	1,196	21,018	22,214	24,829
2004**	3,015	4,028	5,233	5,991	6,885	1,286	22,137	23,423	26,438
2006**	3,101			6,031					
2007**	2,760								
2008**	4,065	4,420	5,558	6,405	5,817	894	22,199	23,094	27,159
Percent change									
1991-2000	-56%	-42%	-25%	-6%	-24%	-65%	-26%	-32%	-35%
2000-2008	+93%	-3%	+39%	+28%	-11%	-45%	+10%	+6%	+14%
2000-2004	+43%	-12%	+31%	+20%	+5%	-21%	+10%	+7%	+11%
2004-2008	+35%	+10%	+6%	+7%	-16%	-30%	0%	-1%	+3%

Table 4. Counts of adult and juvenile Steller sea lions at trend rookery and haul-out sites in the range of the western stock in Alaska by sub-area 1991-2008. Single trend sites were missed in the central and western Gulf of Alaska, and eastern Aleutian Islands during the 2007 survey, and in the western Aleutians Islands during the 2006 survey. The central Aleutian Island sub-area was divided into eastern (Uliaga through Tanaga) and western (Delarof Islands through Kiska) portions. Counts at sites within the Central-East Aleutian Islands sub-area in 2006 and 2007 were averaged and summed. Missed sites have been omitted from the entire sub-area time series to allow aggregation of counts at the largest number of consistently surveyed sites. * For eastern Gulf of Alaska in 1998, counts made in 1999 were substituted for those sites not surveyed in 1998. Sub-area count totals in 2004-2008 (**) have been adjusted to account for resolution differences between film formats.

	Gulf of Alaska			**Aleutian Islands**						
Year	**Eastern**	**Central**	**Western**	**Eastern**	**Central-East**	**Central-West**	**Western**	**Kenai-Tanaga**	**Kenai-Kiska**	**Total**
1991	4,812	7,741	5,166	5,253	3,989	4,667	4,014	22,149	26,816	35,642
1992	3,981	7,244	4,980	5,631	3,377	4,257	3,746	21,232	25,489	33,215
1994	3,612	6,364	5,534	5,575	3,431	3,478	2,769	20,904	24,382	30,763
1996	2,450	5,272	5,155	5,861	2,906	3,462	3,022	19,194	22,656	28,128
1998*	2,158	4,736	5,131	5,700	3,673	3,344	2,450	19,240	22,584	27,192
2000	2,102	4,519	3,926	4,916	3,761	2,799	1,504	17,122	19,921	23,527
2002	2,615	4,513	4,509	5,209	4,111	2,436	1,102	18,342	20,778	24,495
2004**	3,015	3,997	5,217	5,876	4,323	2,562	1,182	19,413	21,975	26,172
2006**	3,101			5,961	3,647		961	19,976		
2007**	2,760	4,663	5,632	6,033						
2008**	4,065	4,363	5,557	6,344	3,585	2,232	853	19,849	22,081	27,000
Percent change										
1991-2000	-56%	-42%	-24%	-6%	-6%	-40%	-63%	-23%	-26%	-34%
2000-2008	+93%	-3%	+42%	+29%	-5%	-20%	-43%	+16%	+11%	+15%
2000-2004	+43%	-12%	+33%	+20%	+15%	-8%	-21%	+13%	+10%	+11%
2004-2008	+35%	+9%	+7%	+8%	-17%	-13%	-28%	+2%	0%	+3%
2004-2007	-8%	+17%	+8%	+3%	-16%			+3%		
2007-2008	+47%	-6%	-1%	+5%	-2%			-1%		
Missing Site		Long	Kak	Umnak C. Aslik			Buldir			

Table 5. Counts of Steller sea lion pups at selected rookeries in seven sub-areas of the western stock in Alaska from 1978-1979 to 2005-2007. Blank cells indicate incomplete counts in the period and sub-area. Percentage change in counts between periods is also shown.

	Gulf of Alaska			**Aleutian Islands**				**Western**
	Eastern	**Central**	**Western**	**Eastern**	**Central**	**Western**	**Kenai to**	**Stock**
Years	(n=2)	(n=5)	(n=4)	(n=5)	(n=11)*	(n=4)	**Kiska**	**in AK**
1978-1979	574	18,893	9,351					
1985-1989		10,254	5,879	4,778	9,382		30,114	
1990-1992		4,904	1,923	2,115	3,568		12,510	
1994	903	2,831	1,662	1,756	3,109		9,358	
1997	611					979		
1998	689	1,876	1,493	1,474	2,834	803	7,677	9,169
2001-2002	586	1,721	1,671	1,561	2,612	488	7,565	8,639
2003-2004	716	1,609	1,577	1,731				
2005-2007	715	1,683	1,707	1,955	2,555	343	7,900	8,958
Percent Change								
1978-79 to 2001-02	+2%	-91%	-82%					
2001-02 to 2005-07	+22%	-2%	+2%	+25%	-2%	-30%	+4%	+4%
1998 to 2005-07	+4%	-10%	+14%	+33%	-10%	-57%	+3%	-2%

* 1985-89 CAI count does not include Amchitka/Column Rocks (n=10)
2005-2007 CAI count includes 2004 count from Yunaska

Figure 1. Terrestrial rookery and haul-out sites in the range of eastern and western stocks of Steller sea lions in Alaska surveyed in 2008 and used in the analysis of population trends. Boundaries of the eastern, central, and western regions of the Gulf of Alaska (GOA) and Aleutian Islands (AI) are shown. The eastern and western stocks breed on rookeries east and west of 144°W, respectively.

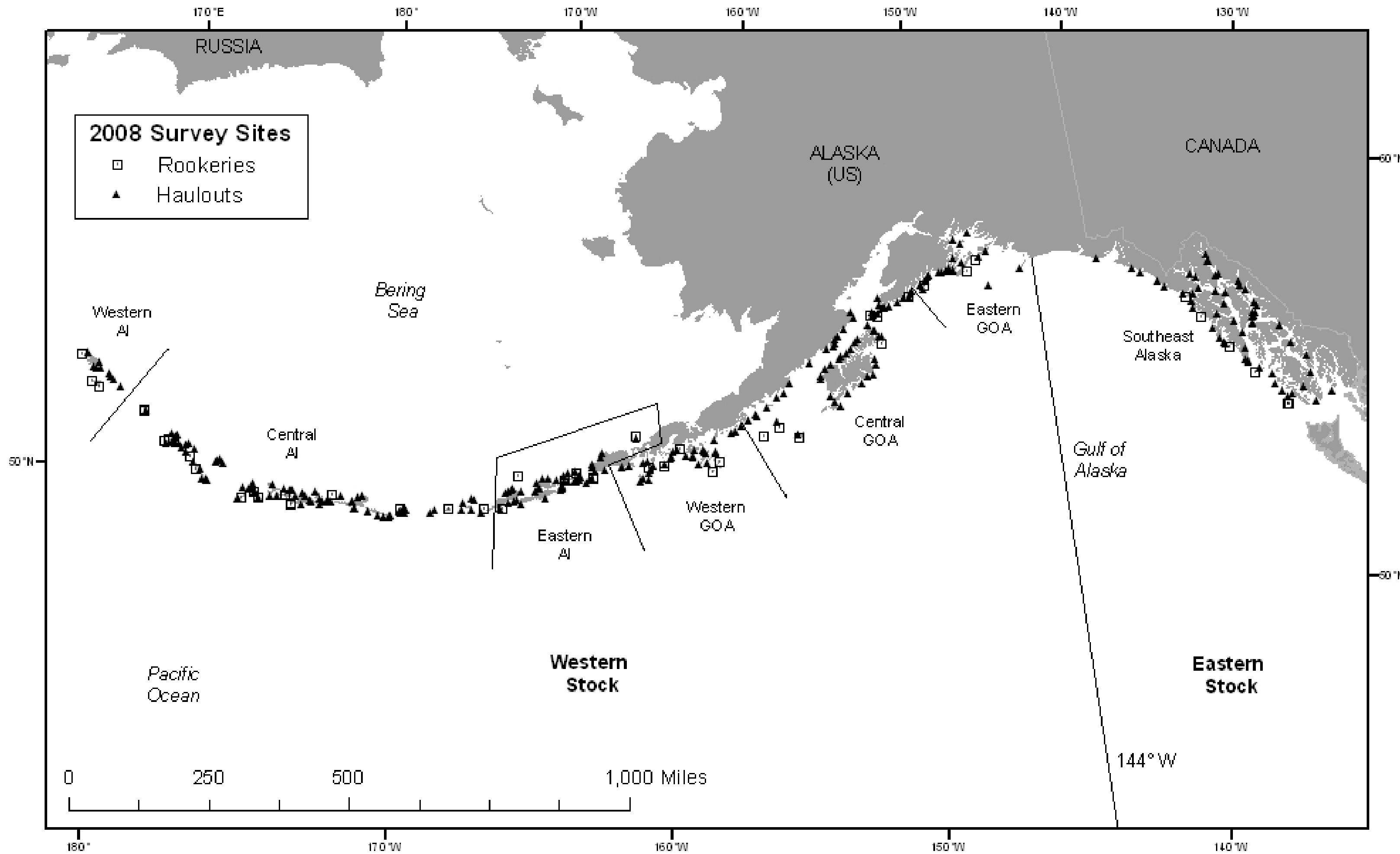
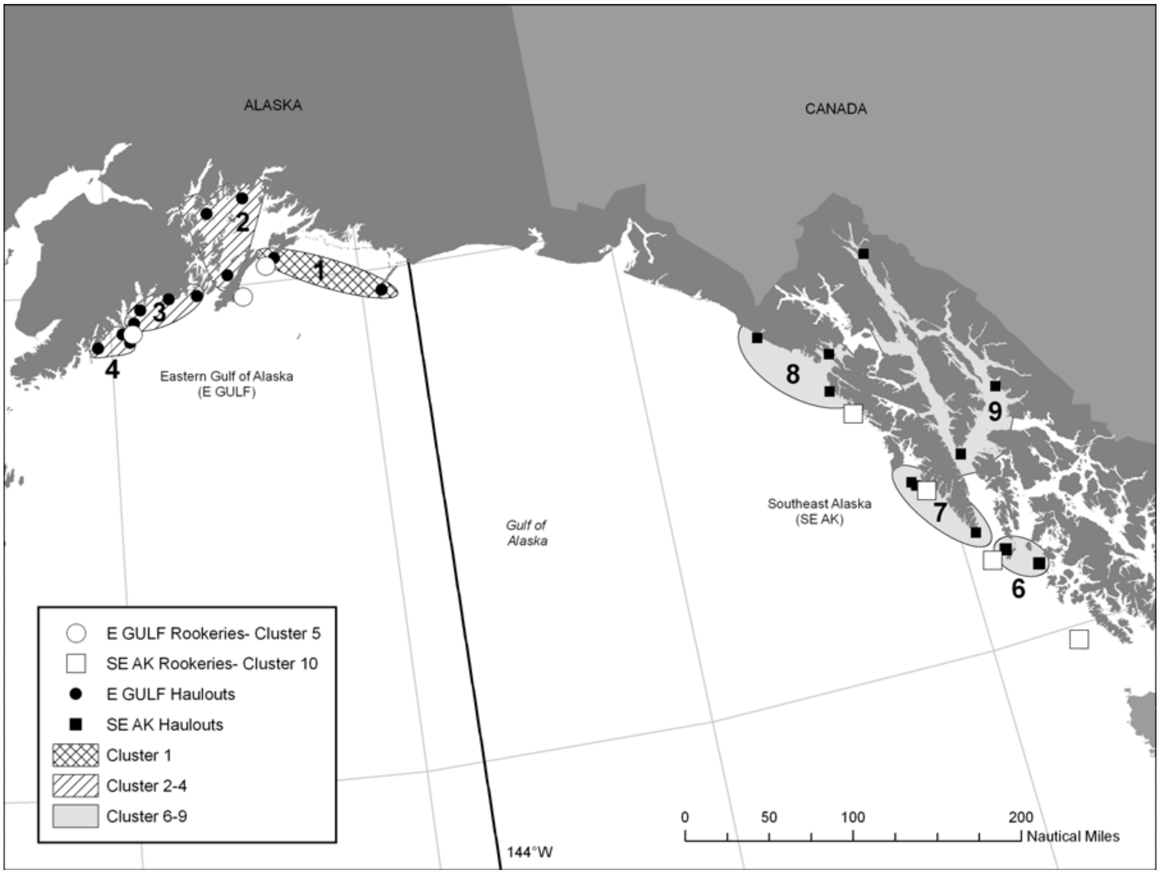


Figure 2. Clusters of haul-out and rookery sites used in analysis of non-pup Steller sea lion counts in the southeast Alaska and E GULF regions.



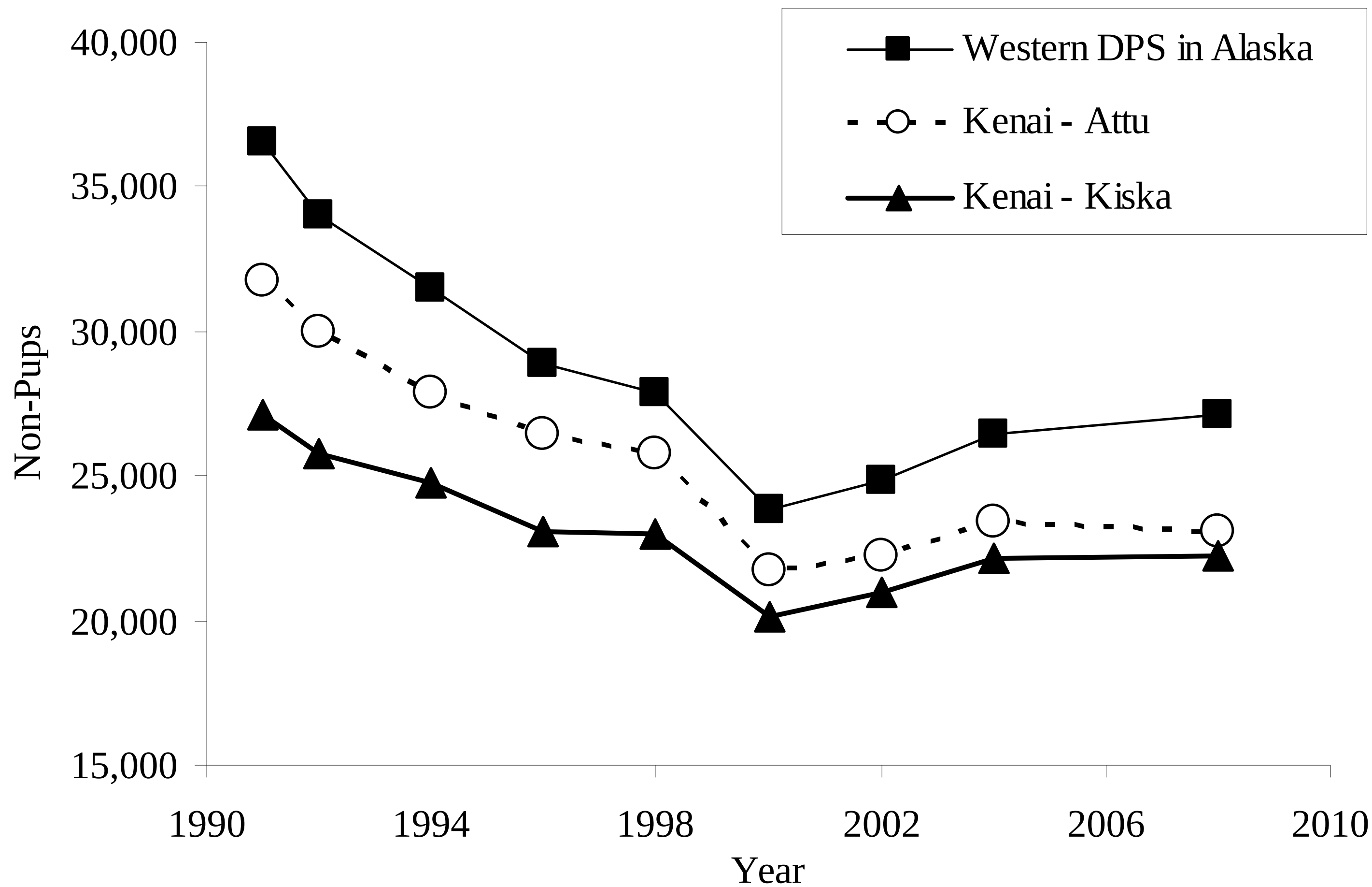


Figure 3. Total counts of adult and juvenile Steller sea lions at trend haul-out and rookery sites within the range of the western stock in Alaska, 1991-2008 (Figure 1). Data are from Table 3. “Kenai – Kiska” consists of the central and eastern Aleutian Island regions, and the western and central Gulf of Alaska. “Kenai – Attu” consists of the Kenai – Kiska region plus the western Aleutian Islands.

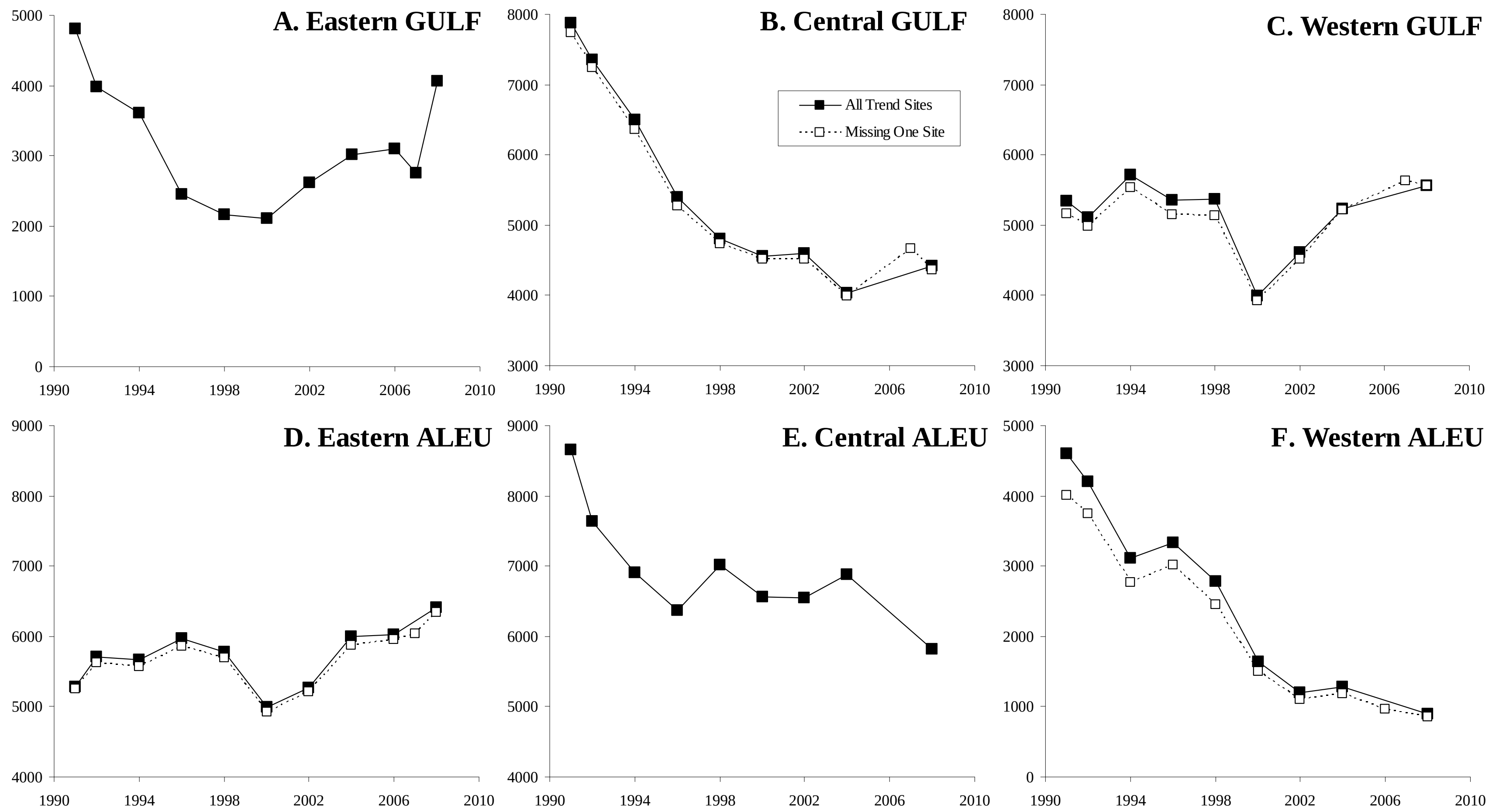


Figure 4. Total counts of adult and juvenile Steller sea lions at trend haul-out and rookery sites in 6 sub-areas within the range of the western stock in Alaska, 1991-2008. See Figure 1 for sub-area locations. Legend in B applies to all graphs. Data are from Tables 3 and 4. Missing sites are: Long Island in the Central Gulf (B), Kak Island in the Western Gulf (C), Umnak/Cape Aslik in the Eastern Aleutians (D), and Buldir Island in the Western Aleutians (F).

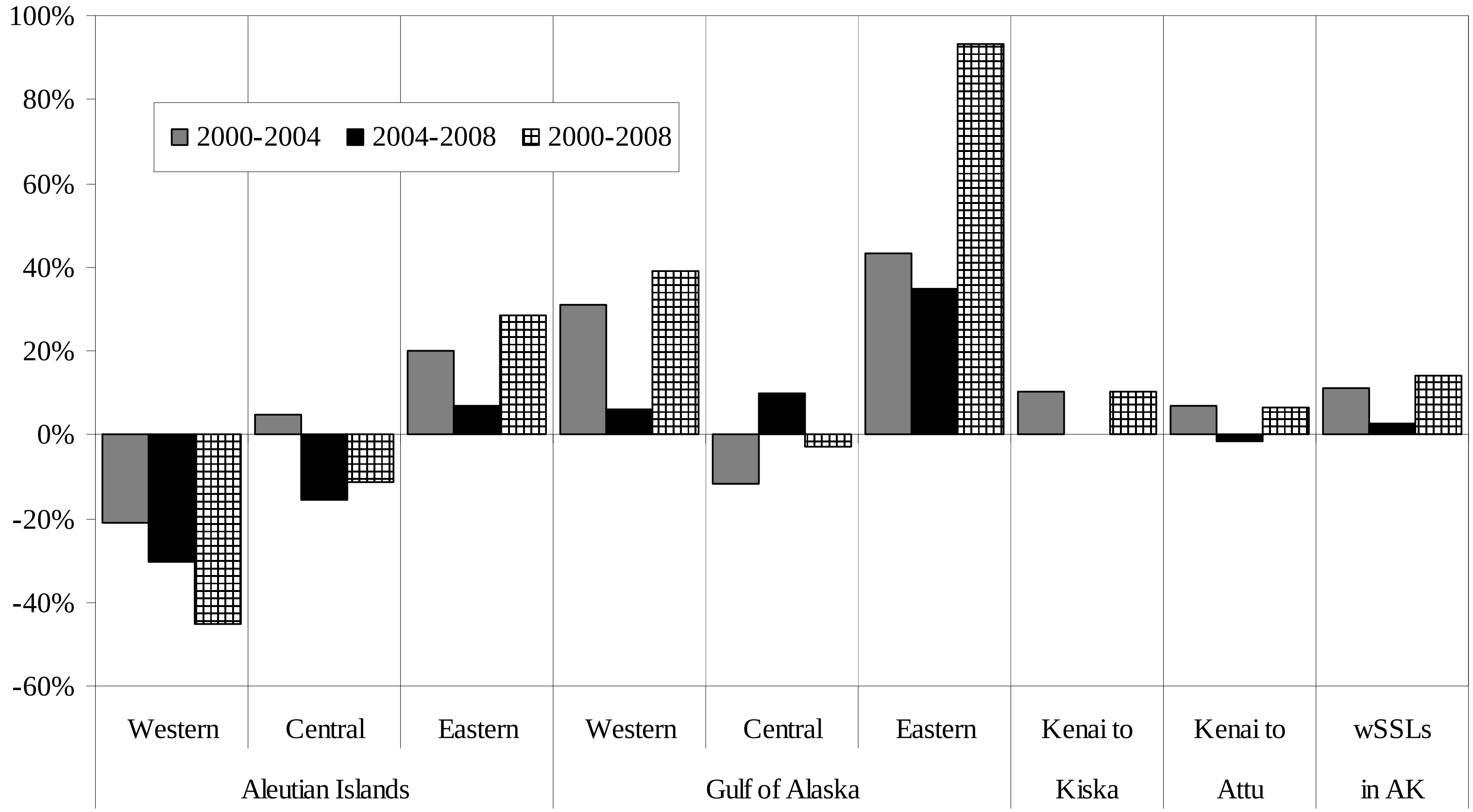


Figure 5. Percentage change in regional non-pup count totals between 2000 and 2004, 2004 and 2008, and the entire 2000-2008 period. Data are in Table 3.

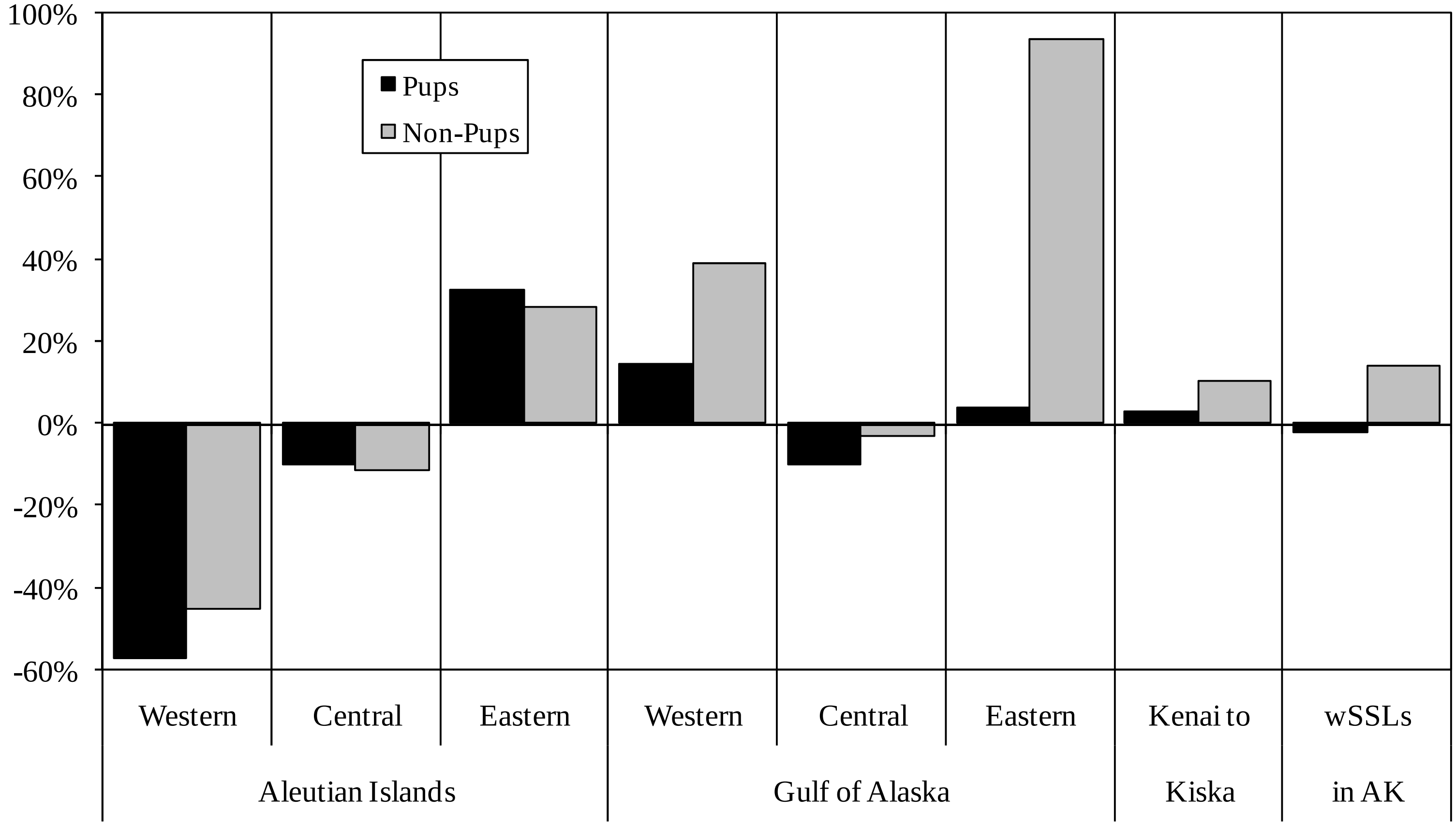


Figure 6. Percentage change in pup counts between 1998 and 2005/07 (Table 5) and non-pup counts between 2000 and 2008 (Table 3) by region within the range of the western stock of Steller sea lions (wSSLs) in Alaska.

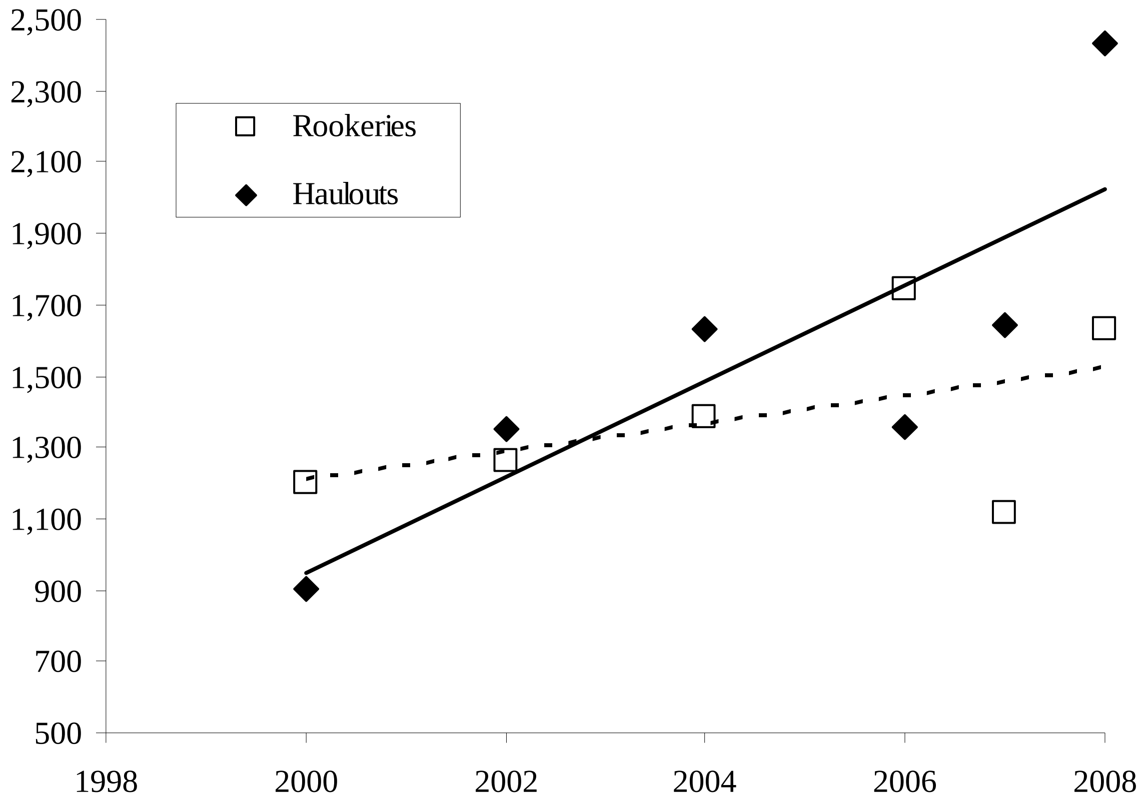


Figure 7. Counts of non-pup Steller sea lions in the eastern Gulf of Alaska on trend haul-out and rookery sites, 2000-2008. Counts at haul-outs increased significantly at 9% per year (P=0.03), while the slope in trend rookery counts is not significantly different from 0 (P=0.35).

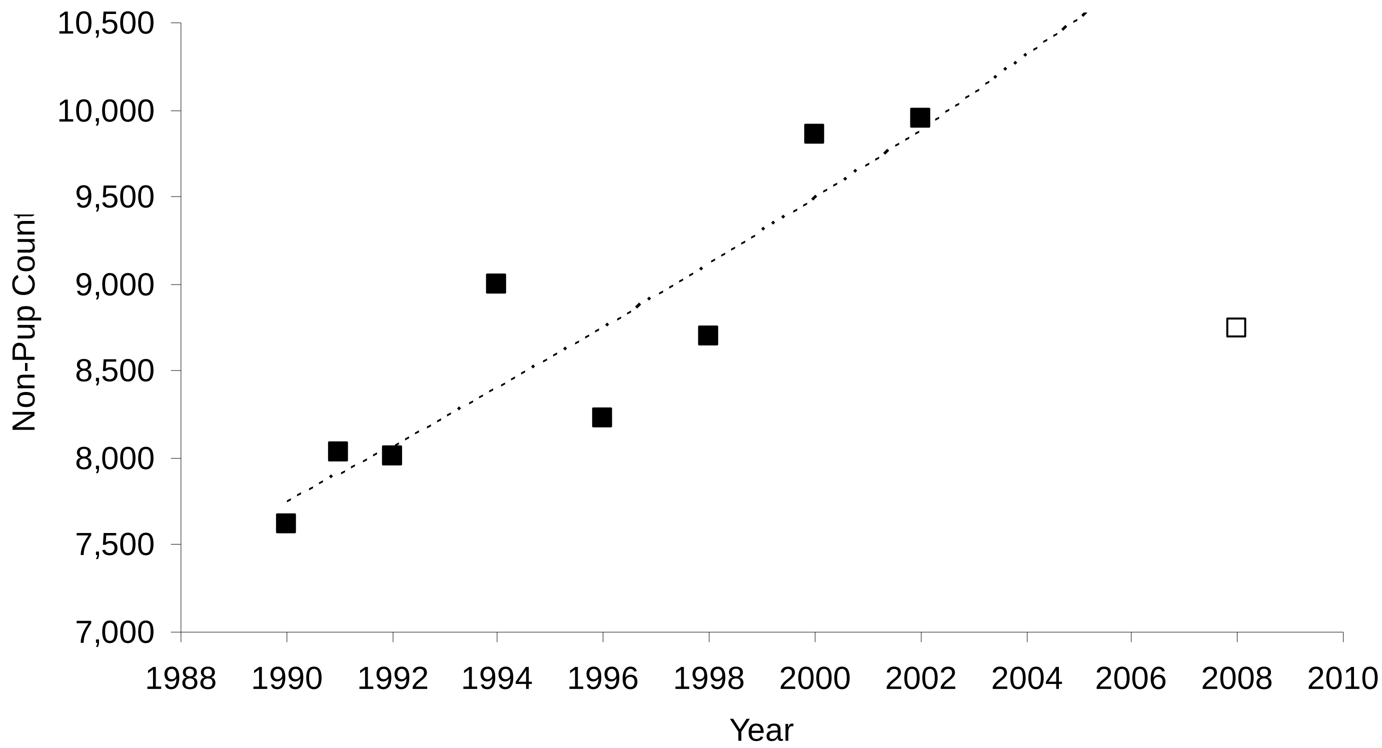
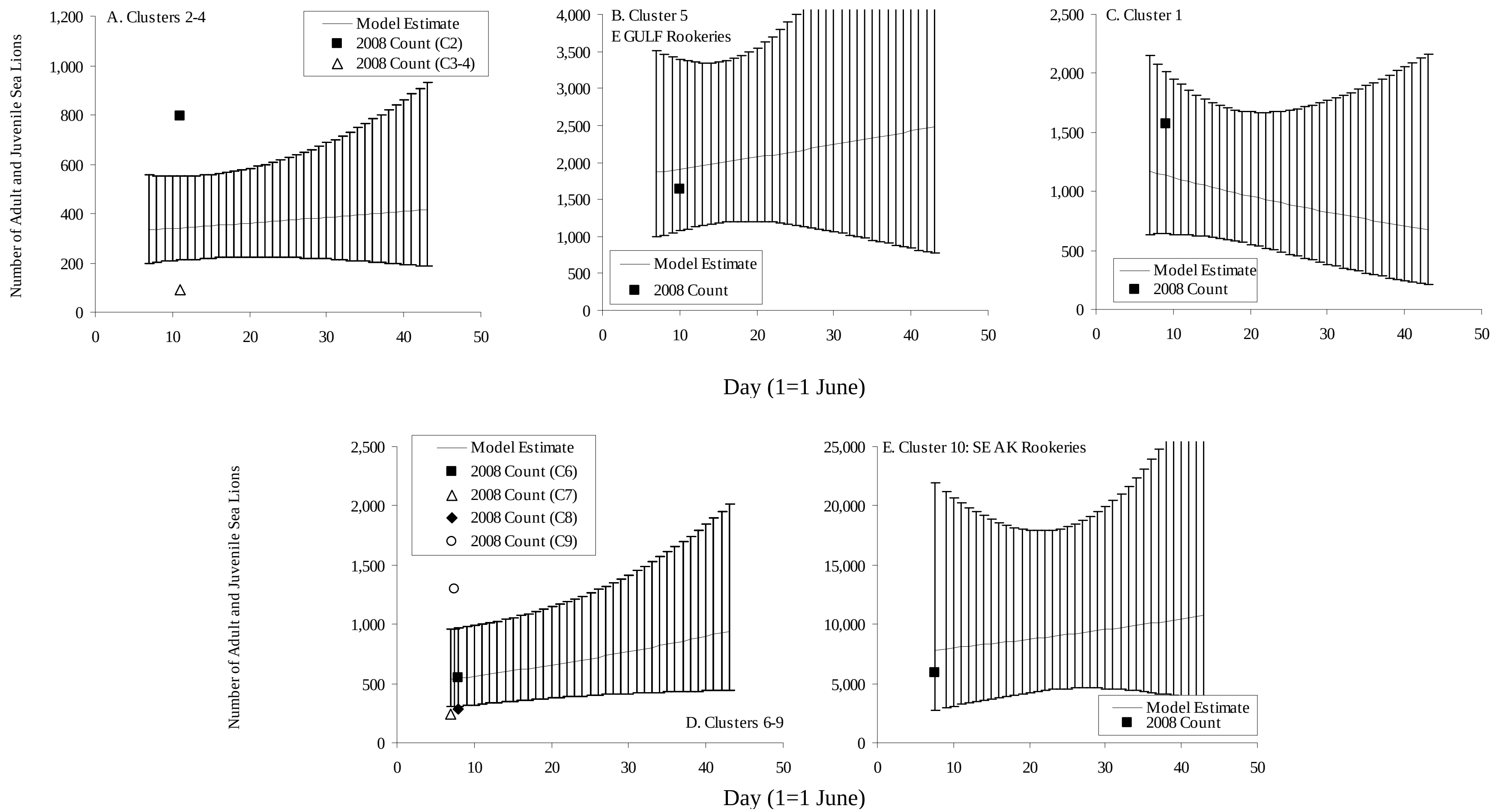


Figure 8. Total counts of adult and juvenile Steller sea lions at 10 trend haul-out and rookery sites in southeast Alaska, 1990-2008. Trend sites included Biali Rock, Cape Cross, Coronation, Forrester Complex, Graves Rock, Harbor Point, Hazy, Jacob Rock, The Brothers, and White Sisters. Regression line (dotted; $r^2 = 0.81$) does not include 2008 data (open symbol); growth rate based on 1990-2002 non-pup counts was 2.1% per year.

Figure 9. Counts of adult and juvenile Steller sea lions in clusters of haul-outs and rookeries in the eastern Gulf of Alaska (E GULF) and southeast Alaska (southeast Alaska) in 2008 plotted against day of the year (1=1 June). Actual counts are plotted as points, and model estimates as lines with 95% confidence bounds. See text for details of model structure.



Appendix E.

Evaluation of Hotbranding

Evaluation of Hot Branding and Other Marking Techniques Used to Individually Identify Steller Sea Lions and other pinnipeds.

Studies to determine vital rates, movement patterns, and distribution of Steller sea lions (*Eumetopias jubatus*) and other pinnipeds rely on observations of "known" or "individually identifiable animals. Such work has been carried out using natural marks, temporary marks such as paint, dyes, and plastic flipper tags. However, the most successful approach employed has been the permanent marking of sea lion pups (and some non-pups) with individually identifiable hot-iron brands (letter and number combinations). While authorization to conduct such marking and field implementation has come and gone with legal challenges and budgetary constraints, no other technique has been shown to be as effective in meeting high priority research objectives. Two workshops hosted by the Steller Sea Lion Recovery Team in the late 1990s and a peer review workshop hosted by the North Pacific Fishery Management Council to review a NMFS ESA Section 7 biological opinion (Bowen et al. 2001) independently recommended that such branding be resumed in order to provide a sufficiently large number of marked animals to calculate age-specific mortality and reproductive rates. It was hoped that these efforts would facilitate determination of reasons for the Steller sea lion decline.

WHY PERMANENT MARKS AND WHY HOT-IRON BRANDS

<u>Hot-iron Brands</u>

Hot-iron branding is the preferred method for producing permanent markings on sea lions safely and effectively. Hot-iron branding has been used extensively as a method to permanently mark pinnipeds, as well as livestock and large birds. The brands are applied with irons (numbers and letters) heated with a portable propane forge. Melin et al. (unpublished data) note their branding of California sea lions (*Zalophus californianus*) is providing a wealth of information on movements and distribution of sea lions, spatial segregation of the sex and ages, and most important a means to estimate and examine the factors that affect survival and natality rates. Branding provides a permanent mark, which is not subject to the same problems as plastic or metal tags that become worn and unreadable or fall off. Also, the brand can be easily read from a distance providing much higher resight rates than tags. Also, tag loss is high for Alaskan SSL; of 399 pups branded and flipper-tagged in June 1994, only 2 individuals have been observed with tags after their year of tagging (ADF&G, unpublished data). Observed tag losses from resights of pups tagged and branded in 2001-2002 (n = 226) suggest *minimum* single tag loss estimates (not accounting for probability of observing whether a tag was lost or retained) of 0.08 and 0.32 by 1 yr of age and 0.19 and 0.40 by 3 yrs of age, for two types of Allflex flipper tags (ADF&G unpublished data).

Hot-iron branding has proven effective in practice on Steller sea lions. The ADF&G branded 7,046 Steller sea lions with a single character at several rookeries and haulouts in Alaska in 1975-1976 (Table 1). The NMFS, with ADF&G and the Soviet Union [Pacific Research Institute of Marine Fisheries and Oceanography (TINRO)], branded 1,489 Steller sea lion pups at Marmot Island, Alaska, and at four rookeries in the Kuril Islands from 1987 to 1989. Russian scientists with KAMCHATRYBVOD, in collaboration with NMFS, branded more than 500 Steller sea lion pups in the Kuril Islands and Commander Islands in 1996. Over 4,231 sea lion pups have been branded by NMML and ADF&G since 2000 (Table 2a). At San Miguel Island in California, the NMML and cooperators have branded more than 5,000 California sea lions since 1987 (Table 3). In all of these activities there is no evidence suggesting increased mortality of pups after or caused by branding (Table 2b; Merrick et al. 1996; Melin et al. unpubl.; see below).

Merrick et al. (1996) summarized early studies on Steller sea lions using hot-iron branding. They report that one-month survival of 1,489 pups branded in 1987-89 at rookeries in Alaska and Russia was high (99.8%). From 4-9 months later, no difference was found in mortality rates of branded and unbranded pups from sightings on the beach; 95.8% of the 142 brands observed 5-8 months after branding were legible, and 92.3% of the 26 brands observed 6-7 years after branding were legible.

A mark-recapture study conducted for 3-months post-branding in 2001-2002 at Lowrie Island found weekly survival of branded pups was nearly identical to estimates from a control group of undisturbed/unbranded pups born to 10-11 yr old branded adult females in 2005 (0.987-0.988/wk). These survival rates were similar to pup survival estimates of other otariid studies. Assuming survival differences between the first 2 weeks post-branding and later weeks was due entirely to the branding event (i.e. no additional natural mortality), potential mortality attributable to the branding event was 0.005-0.006. Although potential effects of maternal age, site, and year on pup survival could not be eliminated, available data indicated significant mortality did not result from the branding event (Hastings et al. *In Review*).

Freeze Brands

Freeze branding has been suggested as a viable alternative to hot-iron branding. However, Merrick et al. (1996) suggest that hot-iron branding is superior to freeze branding because of fewer logistical problems associated with transporting coolants to remote locations, a better chance of producing permanent, legible marks, and equivocal differences in stress responses of animals (it takes longer to make the freeze mark, but tissues may heal faster).

Freeze branding uses dry ice coolant, Freon 22 (applied to the skin or using a nozzle), or liquid nitrogen (e.g., NMML, 1976). Short contact time of the frozen instrument destroys the pigment-producing hair follicle resulting in un-pigmented white hair during regrowth. Longer contact time destroys both the pigment producing follicle and hair shaft growth follicle, resulting in a hairless or bald brand (Freeman and Lee 1989). Cornell et al. (1979) reported on experiments using freeze branding and noted that blurring can occur because the iron must be in steady contact with the skin for 45-60 seconds (versus 3 sec. with hot-iron brands) and at 10-15 psi (hot-iron brands are applied with low pressure). Higher pressures resulted in blurred marks. Harkonen (1987) reports on studies using freeze-branding to mark harbor seals (*Phoca vitulina*). He used brass irons cooled in ethanol and carbon-dioxide ice, applied for 17-22 seconds at a pressure of 4.5 kg. He reported no open wounds and that mortality was no different than non-branded, marked seals. The brands were visible from 700 m for 5 years, but 18% were illegible and 16% were very difficult to discern. Boyle et al. (unpubl.) applied freeze brands to 20 pre-molt New Zealand fur seal (*Arctocephalus forsteri*) pups and monitored the animals at 4, 17, and 41 days. They found that brands were visible for at least the 41 days. However, they noted that considerable handling time was needed for each application (principally clipping the fur to allow contact of the copper iron with the skin), but that it seemed to cause less stress to the animal than hot-iron branding (but see below re: gas anesthesia).

Troy et al. (1997) used both hot-iron and freeze branding on adult male New Zealand fur seals (*A. forsteri*). In one year, all fur seals were freeze-branded, whereas all were hot-iron branded the following year. Freeze brands were not legible after the first molt, but became legible following the second molt. Hot-iron brands were legible after the first molt, but 2 had infections 6 months later. They recommended freeze-branding over hot-iron branding because of the lower chance of infection and "over-branding." If first-year resights were necessary, then freeze branding should be supplemented with temporary markings such as tags. Larger males regained territories following the procedure; those that were unsuccessful were significantly lower in weight. The majority of seals under anaesthetic regained territories within 5 days.

<u>Other Marks</u>

Natural marks have also been used to identify animals. This method has been used on a small sample of pinnipeds, but it does not provide information on enough individuals to address questions on vital rates, population dynamics, dispersal, and mortality/natality by age.

Passive induction transponders (PIT tags) have been used on some marine mammals, but the disadvantage to this technique is that a "reader" wand must be passed within a few centimeters of the tag in order to identify the animal (read the tag). For most pinniped species this is not a viable option. Additionally, with no external "mark" on the animal it is unknown if the failure to read the tag is due to the lack of a tag, a present but non-functioning tag, or poor technique.

Other marking options that have been used in varying situations with little success are tattooing, web punching, or other anatomical alterations. These techniques have not been considered as viable options for use on Steller sea lions. A more thorough review of other marking techniques can be found in Erickson et al. (1993)

EXPERIMENTAL DESIGN

The hot-iron branding program conducted by NMFS and ADF&G will eventually provide age-specific survival rates for the eastern and western DPS's (distinct population segment) of Steller sea lions, with the ultimate goal of identifying the age and sex of highest mortality, which may facilitate identification of reasons for decline in abundance. Concomitant to this broader goal will be more detailed determinations of metapopulation age-specific survival rates (e.g., central Gulf of Alaska versus southeast Alaska), age-specific reproductive rates, dispersal from natal rookeries by age and sex, site fidelity, and validation of genetic stock dispersal models. Each topic requires a long-term marking program across a broad geographic range and each requires different study duration and sample size. In general terms, the marking program must occur for multiple years and include hundreds of animals at each marking site each year. More details are provided below.

<u>How Many Years Might Branding Need to Occur?</u>

This is a question that is directly tied to the objectives of the work. At a minimum, in order for basic life history attributes to be obtained, animals should be marked for at least long enough to be able to detect inter-annual variation in survival among different sites. The subsequent resighting effort is crucial here and has to be consistent throughout the life span of the animals. If inter-annual variation is determined to be low or measurable, branding may only be necessary on intervals (e.g. every 3-5 years). This would maintain a "window" of marked animals within the population that with continued resighting would allow for changes in survival to be documented. However, permanently marking sea lions annually may also be necessary for additional studies examining questions at the rookery level where individual identification is necessary each year.

In general, detecting changes in abundance (i.e., monitoring studies) requires 10 years or more for a species where count or index data are highly variable from year to year and where the rate of change is typically less than 10% per year. The National Research Council (2003) report on the cause of the Steller sea lion decline recommended that adaptive management type experiments would take 5-10 years. These experiments include calculation of vital rates and movement/dispersion between rookeries based on marked animals.

How Many May Need to Be Branded

Initial simulation studies suggested that survival estimates with coefficients of variation (CVs) of < 0.125 should result from > 600 animals branded, assuming probabilities of resighting branded 4 and 5 year-old animals were greater than 0.1 and 0.3, respectively. The ADF&G Steller sea lion program has estimated it would be appropriate to brand 200 pups per year at up to four rookeries in Southeast Alaska (800 per year total and allowing 1-3 years between branding years), or brand at fewer rookeries per year (600) and alternate rookeries where pups are branded among years. From 2000-2005, 1,475 pups have been branded at western stock rookeries, whereas 1,995 at Southeast Alaska (eastern stock) rookeries (Table 2a).

Preliminary analyses of resighting data collected to date on animals branded in 2000-2002 at western stock rookeries (n=627) suggests that the current brand-resight protocol will yield age and sex-specific estimates of survival for pooled rookeries with CVs less than 7%. This level of precision exceeds that predicted because resight probabilities were generally much larger than anticipated, and will enable the detection of differences in survival rates between age, sex or rookery groups that are on the order of 15%. This relatively large detectable difference in survival rate is likely to be reduced as more resight data are collected and as the pool of branded animals increases. If branding continues as planned through at least 2007, it is estimated that CVs of pooled rookery age-specific survival rate estimates will be reduced to approximately 4%.

Likewise the level of branding and resighting effort from 2001-2005 in Southeast Alaska, eastern stock has been sufficient to precisely estimate age-specific survival estimates, and has demonstrated age, sex, and natal rookery variation in survival probabilities; and effects of age, sex, and year of observation on resighting probabilities (Hastings et al. 2006). Annual survival probabilities ranged from 0.50-0.70 to age 1, 0.60-0.80 from ages 1 to 2, and up to 0.85-0.95 by age 4-5 yrs of age (Hastings et al. 2006). CVs of survival estimates from all rookeries but Graves Rock averaged 0.032 (minimum = 0.013, maximum 0.054). Only 93 animals were branded at Graves Rock due to the small size of this rookery (98 pups counted in 2002), and given significant variation in survival among rookeries, survival estimates of Graves Rock animals were very imprecise to age 1 (CVs = 0.09 and 0.10 for females and males, respectively) and could not be estimated for animals >1 year of age. Resighting rates in this study were high, ranging from 0.65-0.70 for 1-2 yr old females and males of any age, to 0.80-0.90 for 3-5 yr old females (at 3-5 yrs, resighting rate of males was 0.19-0.23 lower than that of females). Reproductive rate studies in 2005-2006 demonstrated 0.70-0.75 of females ≥ 10 yrs of age at Forrester Islands had pups versus 0.41 of 5-6 yr old females and 0.00-0.03 of 4 yr old females (these are proportions seen with pup and not mark-recapture estimates). Age-specific reproductive rates will be estimated with these data using mark-recapture models to account for resighting probabilities of breeders versus non-breeders, and accounting for probability of classifying females correctly as with pup.

Resight probabilities and the standard errors of survival rate estimates may also vary between rookeries in the western stock. Animals branded at Ugamak Island had lower resight probabilities and less precise survival rate estimates than animals branded at other western stock rookeries. This is most likely due to the fact that there is less resight effort within the probable distribution of animals branded at Ugamak than at other western stock rookeries. If the number of animals branded at Ugamak between 2000-2002 were twice the actual, CVs were reduced by only approximately 4% on average. Pooling data across rookeries significantly improved the precision of the survival estimates (CVs less than 0.1) but at the expense of spatial resolution.

Data Collection Procedures and Resight Protocols

The ADF&G and NMFS have convened two workshops to develop brand resight protocols and methods that can be used by observers from land and water in a consistent manner to assure data compatibility and analysis. To this end, a brand resight computer presentation has been developed by ADF&G for use by all individuals that may be involved in resight efforts. Specific forms with instructions have been prepared and distributed for use. Included in the protocol is the recommendation to obtain digital photographs (e.g., use of a Nikon D1 digital camera with 70-300 mm zoom lens) of animals with brands to confirm the observed identification. Numerous resight training excursions have occurred in the field to further develop the protocol and to train naive observers.

Efforts to resight branded animals have been accomplished through the use of dedicated vessel surveys and field camps by both the NMML and ADFG, as well as opportunistically by researchers working on sea lion or other research. Dedicated resight efforts consist of observations of sea lions on land by personnel either stationed for several months at field camps on selected rookery and haulout sites or onboard research vessels. Field camps have been routinely occupied during the summer at Forrester and Marmot Islands since the mid 1990s and mid 1980s, respectively, to look for branded sea lions and in particular, collect evidence of their breeding success. Extended field camp observations of sea lions have also been made on Ugamak, Fish, Sugarloaf, and Timbered Islands. More recently, video cameras positioned on

Chiswell Island and Benjamin Island (SEA), Rogue Reef (OR), and St. George Reef (CA), and Seal Rocks, also provide brand resight effort. Vessel resight cruises are 2-4 weeks in duration and usually occur May – August in the eastern DPS. Sea lions on 50-70 rookery and haulout sites are observed for brands during each of these cruises, which have occurred in British Columbia, Southeast Alaska, Prince William Sound, the Kodiak archipelago, the western Gulf of Alaska (including the Alaska Peninsula and the Shumagin Islands), and the eastern Aleutian Islands as far west as Adugak. Opportunistic brand resighting occurs during all other sea lion field research, including the pup-related research (e.g., branding, counting, physiology, genetics) in July and the foraging/at-sea movement studies using satellite telemetry, in which juvenile and sub-adult sea lions are captured underwater or on-land. Contact with other researchers working in the Aleutian Islands and the Gulf of Alaska, in particular seabird researchers at USFWS and marine mammal scientists at the University of Alaska, is maintained to remind them to look for and record brands if the opportunity presents itself.

Vital Rate Calculation

Melin et al. (unpubl.) estimated survival rates for California sea lions by using the computer program MARK developed at Colorado State University. MARK provides estimates of sighting probability and survival rate for general, open population, capture-recapture models (e.g., Jolly-Seber) and allows models to specify time- and individual-specific covariates for re-sighting and survival probabilities. The model assumes that observed marked animals are representative of those that were alive but not observed. A variety of models can be fitted that allow sighting probability and survival to vary by age, sex, year, and interactions of these main effects. For sighting probability, age can be classified based on the sea lion's approximate age at the time of sighting. For survival probability, age is classified based on the age of the sea lion during the applicable survival period. Preliminary calculations by NMFS and ADFG staff using MARK on existing Steller sea lion brand resight data confirm that MARK can be used with these data. Age-specific estimates of natality rate can also be constructed as the proportion of branded females seen with a pup divided by the number of branded females seen during the pupping and breeding season. Also possible is use of MARK, mssurviv or POPAN to estimate age-specific reproductive rates using a robust design and estimation of probability of classifying a female correctly as "with pup" (Schwarz and Stobo 2000, Kendall et al 2002).

BRANDING METHOD

It is anticipated that branded pups will be a sub-set of those pups #1½ months old captured and measured on rookeries during the Steller sea lion breeding season (late May to early July; most branding occurs in late June and early July). Small groups of pups are corralled against cliffs or boulders and taken one-by-one to be weighed, measured, and branded. Branding irons are made of cold-rolled steel (approximately 10mm stock); the dimensions of the largest digits are approximately 5cm wide and 8cm high (Merrick et al. 1996). Each iron is heated red hot in a portable, propane-fired forge and applied perpendicularly to the animal's shoulder with light, even pressure (ca. 5 psi) for 2-4 seconds. Digits are 4-5cm apart to insure clarity of numbers. A

3-digit brand requires about 1-2 minutes to complete. Pups are then released. Pups that are very young (e.g., under 20 kg) are not branded. While this screening might potentially bias survival estimates, very few animals (1-3 per 100 handled) meet the rejection criteria.

The NMML/ADFG hot-iron branding project uses methods originally implemented on southern elephant seals (*Mirounga leonina*) at Macquarie Island in the 1950s (Csordas 1995). That is, each branded Steller sea lion pup has a unique letter and number combination with a different letter designated for each rookery (e.g., T is for Marmot Island; X is for Sugarloaf Island). Thus an animal with T44 was the 44th pup branded on Marmot Island. Presently, all brands are on the animal's left side. NMFS and ADFG decided that one side was sufficient since 1) it reduces handling time and would thus allow a greater overall sample size, 2) typically the brands are large enough to be noticed, even if only on one side, and 3) it seemed likely that as the program progressed, it may be necessary to switch to the right side and start the number/letter sequence over once too many digits were applied to one side (e.g., >five characters).

EFFECTS OF BRANDING ON THE ANIMAL

Pain and Suffering

NMML and ADFG use gas anesthesia (isoflurane) to render the animal unconscious during the branding process. This reduces stress on pups and improves the quality of brands by preventing wiggling during branding. The equipment and techniques used are those developed and described in detail by Heath et al. (1996). This technique has been used extensively with Steller and California sea lions, both adults and pups, and was in fact developed primarily for and during field operations on these species in collaboration with the NMML and the ADF&G. Anesthesia is delivered to hand-restrained pups through a mask, which is sufficient for the time requirements of branding. Gas anesthesia has proven safe and effective with sea lions.

Mortality and Growth

Hot-iron branding of California sea lion pups was evaluated beginning in 1987, with a cooperative study between NMML and the SWFSC. From 1987 through 1989, 200 pups were branded annually and the brands were evaluated for healing, brand quality, growth rates of branded and unbranded pups at 3-4 months of age, and resight rate (un-branded pups were tagged). The brands were found to produce good permanent marks and there was no evidence of any mortality of individuals caused by the branding nor was there any significant difference in the growth rates (as measured by weight gain) of branded and control pups (DeLong, unpubl.)

Aurioles et al. (1988) branded 97 California sea lions in 1980-1982. Based on their resight data and mortality calculations, they found that 1) branding did not seem to cause significant mortality, 2) branded pups appeared to be as healthy as non-branded pups, 3) most branded pups (89%, 90%, and 93%, respectively, in each of the 3 years) were alive 6 months after branding, 4) mortality rates for years that pups were branded did not differ from years when no pups were branded, and 5) the number of dead pups present on the rookery in non-branding and branding years indicated that survival was independent of branding.

Beck et al. (1984) analyzed brand and tag data from a study on >1900 gray seals in 1963-1978 and concluded that branding caused no additional mortality compared to just tagging. Numerous other examples on other species are in the literature (Table 3).

A mark-recapture study conducted for 3-months post-branding in 2001-2002 at Lowrie Island found weekly survival of branded pups was nearly identical to estimates from a control group of undisturbed/unbranded pups born to 10-11 yr old branded adult females in 2005 (0.987-0.988/wk), and similar to pup survival estimates from other otariid studies. Assuming survival differences between the first 2 weeks post-branding and later weeks was due entirely to the branding event (i.e. no additional natural mortality), potential mortality attributable to the branding event was 0.005-0.006. Although potential effects of maternal age, site and year on pup survival could not be eliminated, the available data indicated significant mortality did not result from the branding event (Hastings et al. *In Review*).

An estimate of mortality from the branding event can be calculated based on Steller sea lion branding activities from 2000 to 2004 (Table 2b). Assuming that each visit to a rookery for branding is an independent sampling 'event', then a mortality ratio (deaths/branded pups) can be estimated, though in reality the mortality is due solely to the activity (and pup behavior) rather than the branding per se. Mortality rates appear to be highest in southeast Alaska (Table 2b), likely due to handling pups on higher density rookeries laden with cracks and pools. Results suggest that if 800 pups are to be branded each year (400 in each stock), 5 (∀3) pup mortalities could reasonably be expected to occur. Of these, only one would occur in the endangered western stock.

In unpublished studies to assess the effects of branding on Steller sea lion growth, ADFG and NMFS examined 371 juvenile Steller sea lions captured with hoop net or underwater noose techniques during 2000-2003; 27 of these had been branded as pups on natal rookeries. The pups did not differ in mass or length compared to non-branded sea lions of similar age up to 2 years of age (Figures 1 and 2), suggesting there was no effect of branding on subsequent growth. This conclusion was further supported by examination of the distribution of residuals from an analysis of covariance of mass (log-transformed) by sex, branding status (yes/no), and region (natal region for branded pups, region of capture for non-branded pups) with age (log transformed) as a covariate (Figure 3). Though there were significant effects of sex, region and age and the overall model accounted for 71% of variance in mass, there was no significant effect of branding (ANCOVA $F_{(1,370)}$=0.008, P=0.931).

Effects of Handling

There are few studies directed at the effect of handling pinnipeds. Baker and Johanos (2002) conducted a study on the effects of research handling on the endangered Hawaiian monk seal (*Monachus schauinslandi*) by analyzing differences in subsequent year survival, migration and condition between handled seals and controls between 1983-1998 (n=549 handled seals). Handling included attaching telemetry devices, blood collecting and tagging. No significant differences in one-year resighting rates, migration rates or condition were noted. They concluded that conservative selection procedures and careful handling techniques have no deleterious effects on monk seals.

Goebel et al. (2003) measured differences in survival to the next year and natality for adult female Antarctic fur seals (*A. gazella*) in which a post-canine tooth was removed under isoflurane gas anaesthesia. These females were anaesthetized for >10 min for various procedures, one of which was removal of the first post-canine tooth in a subsample of those processed. No significant differences were found in survival and natality of these adult females when those with and without tooth removal were compared.

<u>Brand Healing and Pathology</u>
New Zealand sea lions (*Phocarctos hookeri*) were hot-iron branded by Wilkinson et al. (2001). They marked 135 adult females and 300 pups (>12 kg); each was also double flipper tagged and implanted with PIT tags. Pups were weighed 12 weeks later and examined for brand healing etc., while adults were examined 1 year later. Of the pups, 10 of 27 (37%) examined had healed brands 12 weeks later, 8 were >95% healed, 3 were 90-95% healed, and 6 were 80-90% healed. 20 of 27 brands were legible. Branding had no effect on pup growth rates after 12 weeks. After 1 year, 10 of 11 pups had completely healed brands and all were legible.

For the adult sea lions, 63 of 98 (64%) examined had healed brands 1 year later, 28 were >95% healed. All brands were legible. Survival rates of the original 135 adult females derived from brands (87%) differed from that assessed from tagging (96%); the authors suggest that tagging overestimates survival rate and that branding is a more appropriate long-term marker for demographic studies than tags.

Duignan et al. (2001) reported on the clinical and pathological assessment of the same animals used in the Wilkinson et al. (2001) study. Approximately 12 weeks after branding they recaptured 23 pups and anaesthetized and weighed them and collected a blood sample. One year later, 16 branded adults were recaptured and anaesthetized. Seven of the pups had completely healed brands, while 16 had incompletely healed brands. Blood was also collected from 19 branded, 24 tagged-only and 11 unmarked pups, as well as all 16 branded and an additional 16 unmarked adults. In four of the pups where healing was "grossly incomplete," there was focal epidermal ulceration with dermal granulation, but all were confined to the brand area in the superficial dermis (<2 mm depth). Serum electrophoretic profiles were indistinguishable among branded, tagged only, or unmarked pups, indicating no acute phase or chronic inflammation from incompletely healed brands. These results suggest that any inflammation associated with branding was localized and had no consequence to the sea lion's overall health.

Mellish et al. (in review) examined the physiological effects of hot iron branding using temporarily captive juvenile Steller sea lions (n=7) at the ASLC. Serum samples were collected over a period of two to eight weeks (day of capture, two weeks post-capture, and 90 minutes, two, and seven weeks post-brand) to examine general inflammatory reactions, acute phase response, and adrenocorticoid levels. Overall, WBC counts, platelet levels, and haptoglobin and globulin values all increased within two weeks after branding (likely a result of minor tissue trauma), but returned to capture levels within 7-8 weeks. However, serum cortisol levels did not differ between pre- and post-brand samples. Mellish et al. concluded that short term immune response did not appear to have any lasting physiological effects that would lead to impaired function or mortality. It was also noted that 22 non-branded individuals displayed no adverse physiological responses to temporary captivity.

<u>What about "Sloppy" Brands?</u>

Despite the complexity of verification procedures, when research involves charismatic fauna, polemic attitudes can develop that are grounded more in emotive than empirical arguments (Green and Bradshaw, in review). Such a situation occurred when a research project that had been running without incident for 9 years was stopped by the Australian government because of unfavorable public reactions to a hot-iron-branding procedure at Macquarie Island. The issue of the undesirable effects of hot-iron branding surfaced in 2000 when local Tasmania media reported that the hot-iron branding of southern elephant seals (*Mirounga leonina*) was causing physical harm to individual animals. Television and newspapers showed images of unhealed brands and suggested that not only were animals harmed but that the science was flawed because in some animals the brand had not healed properly and that some brands were illegible. (See below for full analysis of this study; van den Hoff et al. in press). The result was a political backlash from the Australian government banning future hot-iron brand activities on animals under their jurisdiction. The government contracted with Dr. N. Gales, a veterinarian, to review the Macquarie Island elephant seal hot-iron branding program. Gales reported (2000) on 646 branded seals examined 1 year after branding, with most (89.5%) 1-3 years old and the remainder 4-7 years old. Only 18.7% of brands were classified as fully healed, while the majority (50.2%) were healed but had some scarring; 19.8% had an unhealed component that was open but with no discharge. 1.7% of the brands had an openly discharging wound indicating infection. Unhealed brands decreased with age.

Brands were applied to both sides of the animal with no reheating of the iron between applications (3 seconds for first, 4 seconds for second). A greater percentage of first brands were completely healed than second brands. Condition of pups when branded affected healing, with more complete healing occurring in pups in better condition. The chronic nature of ulcerations in a large number of animals led Gales (2000) to conclude that branding would adversely affect the welfare and fitness of elephant seals. Almost half were considered readable, but a portion of the brand had to be guessed at. Almost 20% had a component that was completely unreadable.

But the best summary of this Macquarie Island southern elephant study uses the complete data set over a longer time period and is provided by van den Hoff et al. (in press). They monitored 14,000 southern elephant seals branded as pups on Macquarie Island between 1993 and 2000 (Gales 2000 reported on a subset of these animals). Van den Hoff et al. (in press) report that all brand wounds healed by age one and that the number of readable brands increased after the first molt and thereafter; the mean number of brand characters with peripheral skin damage decreased over the same period. They suggested that the seal's hair and skin molting process contributed most to the healing of brand wounds. They also noted that the changes in recorded brand quality were so profound that previously unreadable brands became readable and unhealed brand wounds with peripheral skin damage became healed scar tissue over a short time period.

Even good brands may be mis-read. Melin et al. (unpubl) note that the possibility does exist for mis-reading or incorrectly recording brand numbers. The effect of recording an incorrect brand number will depend on the true status (i.e., alive or dead) of the animal represented by the number that was recorded. Incorrectly recording a number of an animal that is alive should not greatly affect the estimate of survival, but could affect the sighting probability estimate. Schwarz and Stobo (1999) used simulation to show that mis-reading brands creates a positive bias in survival for occasions shortly after branding and a negative bias in survival for later occasions. It is difficult to predict the resulting bias because it would depend on the pattern of errors. Extreme care is taken in recording brand numbers and if there is any uncertainty the brand is not recorded.

Since 2002 both NMML and ADF&G have been using digital photographs of all resighted branded animals to increase the accuracy of verification. By comparing photos of the same animal taken at different time periods and using a systematic method of evaluating each digit, the potential for mis-reading the brand is decreased. This method has also proven effective for re-sighting "sloppy" or "smeared" brands. Although the original number may no longer be discernable, the unique mark can still be used for identification and included in survival estimates.

EFFECTS OF BRAND OPERATION ON OTHER SEA LIONS AT THE SITE

The NMML and ADF&G are currently collecting data to assess the effect of branding activities on other sea lions at the rookery site, including photographs and counts to assess changes in distribution, age and sex distribution, behavioral parameters (e.g., number of female/pup pairs), and numbers of mortalities. The only other study available to assess the effects of the branding activity is a student project designed to assess the effects of a pup count in the 1980s. Lewis (1987) compared behaviors and distributions of sea lions on Marmot Island in 1984, when there was a pup count (where all adults were moved into the water) and 1985, when there was no pup count. He found that 1) the incidence of pups being trampled during the count was low, 2) that loss and abandonment of pups by females was significantly greater in 1984 than in 1985, 3) a density dependent response in sea lion displacement from disturbed rookeries: the greatest displacement of non-pups occurred on the largest rookery, which was disturbed twice in 3 days, while less displacement occurred on the smaller rookeries which were disturbed only once, and 4) that females became increasingly aggressive and territorial for about 1 week following the counts, then this subsided. Pup counts caused an increase in the frequency of sea lions stampeding from the rookery in response to natural events for about 3 days, then subsided. He suggested that pup counts be conducted during times and tidal conditions when the number of non-pups present is lowest, that refuge areas with no disturbance be established within rookeries, that counts not be conducted when rookery area is small because of storms and pooling of water (where pups may drown), and that counts be conducted between 20 June and 1 July (after most pups are born and prior to them entering the water).

It should be noted that the behavior of humans during a pup count and pup branding are not the same – pup counts involve walking through the entire rookery (at least during Lewis' study) and effectively disturbing and 'moving' every animal. During branding the entire rookery is not disturbed; if the branding activity is restricted to a few areas on the rookery, then pups out of sight are not disturbed.

CONCLUSIONS

Determination of age-specific survival and vital rates is essential to evaluating multiple hypotheses proposed for the Steller sea lion population decline. Of all marking methods available, only branding produces a permanent mark that can be easily and reliably read from a distance. This allows for higher resight rates with less disturbance than obtainable with other marking methods. Though freeze-branding has been used in some pinniped studies, difficulties with logistics, brand application and legibility exist and thus hot-branding remains a preferable method for Steller sea lion studies. Mortality related to branding at rookeries is low, and a result of pup behavior and anesthesia complications rather than branding. There seem to be no longer term consequences of hot-branding on growth rates or survival, and brand-associated wounds generally heal within the first year of life. Current studies of hot-branded Steller sea lions in the U.S. will provide survival rate estimates with high precision and minimal impact on individuals or populations.

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Table 1. Year, location, and number of Steller sea lion pups hot-iron branded in Russia and the United States.

Year	Location	Number branded	Year	Location	Number branded	Year	Location	Number branded
1975	Marmot	598	1998	Antsiferov	100	2002	Forrester	141
	Sugarloaf	719		Brat Chirpoyev	100		Graves Rock	50
1976	Cape St. Elias	23		Iony	150		Iony	100
	Fish (Wooded)	29		Kozlov	50		Kozlov	50
	Marmot	3669		Medney	87		Marmot	90
	Outer	249		Raykoke	100		Medney	85
	Seal Rocks	316		Srednego	100		St. George Reef	141
	Sugarloaf	1443	1999	Antsiferov	50		Sugarloaf	105
1986	Rogue Reef	56		Brat Chirpoyev	100		White Sisters	126
1987	Marmot	351		Kozlov	50		Yamski	150
	Rogue Reef	55		Lovushki	100	2003	Antsiferov	100
1988	Marmot	400		Medney	100		Brat Chirpoyev	100
	Rogue Reef	92		Raykoke	100		Forrester	291
1989	Brat Chirpoyev	200		Srednego	80		Hazy	101
	Lovushki	200	2000	Marmot	107		Lovushki	77
	Srednego	200		Sugarloaf	151		Seal Rocks	100
	Raykoke	139		Yamsky	90		Raykoke	100
1994	Forrester	399	2001	Antsiferov	100		Rogue Reef	190
1995	Forrester	400		Brat Chirpoyev	76		Srednego	100
1996	Antsiferov	100		Fish	32		Ugamak	150
	Brat Chirpoyev	100		Forrester	286		Medney	54
	Kozlov	50		Glacier	14	2004	Marmot	75
	Medney	100		Hazy	217		Sugarloaf	110
	Lovushki	100		Iony	143			
	Raykoke	100		Lovushki	100		**TOTAL**	**16415**
1997	Antsiferov	100		Medney	95			
	Brat Chirpoyev	100		Raykoke	100			
	Kozlov	50		Rogue Reef	180			
	Lovushki	100		Seal Rocks	75			
	Raykoke	100		Ugamak	177			
				Yamsky	81			

Table 2a. Steller sea lion pups branded by stock, region and natal rookery, 2000-2005. A grand total of 4,231 pups (male: 2,273/female: 1,950/unknown: 8) were branded at natal rookeries in the United States.

Location	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Western Stock						
Eastern Aleutian Islands						
Ugamak[1]		175 (95/80)		150 (80/70)		200 (109/91)
Central Gulf						
Marmot	107 (58/49)		89 (39/50)		75 (38/37)	
Sugarloaf	151 (73/78)		105 (62/43)		110 (59/51)	
Eastern Gulf						
Chiswell						26 (15/11)
Wooded (Fish)		32 (16/16)				
Seal Rocks		75 (42/33)		100 (55/45)		80 (46/34)
Western stock subtotal	**258 (131/127)**	**282 (153/129)**	**194 (101/93)**	**250 (135/115)**	**185 (97/88)**	**306 (170/136)**
Eastern Stock						
Southeast AK						
Forrester Complex[2]		286 (147/137/2)	141 (68/73)	291 (186/105)	277 (148/129)	
Hazy		213 (112/100/1)		101 (57/43/1)		225 (115/109/1)
Graves Rock			50 (34/16)			43 (24/19)
White Sisters			127 (69/57/1)		94 (54/40)	147 (89/58)
Oregon						
Rogue Reef[3]		180 (100/80)		190 (99/91)		100 (43/57)
California						
St. George Reef[4]			140 (65/73/2)		151 (76/75)	
Eastern stock subtotal		**679 (358/318/3)**	**458 (236/219/3)**	**582 (341/240/1)**	**522 (278/244)**	**515 (271/243/1)**
Total	**258 (131/127)**	**961 (512/446/3)**	**652 (337/312/3)**	**832 (477/354/1)**	**707 (375/332)**	**821 (441/379/1)**

[1]Ugamak Bay and Ugamak North.

[2]Cape Horn Rock, Lowrie, North Rock, and Sea Lion Rock.

[3]Pyramid Rock.

[4]Includes SW Seal Rock.

Table 2b. Estimates of mortality rates (*m*, mortalities per animal handled) for Steller sea lion as a consequence of pup branding activities shown in Table 2a. All mortalities resulted from suffocation or drowning from pups piling when corralled, none resulted from branding. Ratio and standard error determined using ratio estimator method. "Events" are the number of rookeries visited for branding.

Group	Stock	Period	Mortalities	Handled	*m*	*SE (m)*	Events
NMML-AEP[1]	western	2000-2004	2	1169	0.002	0.002	13
NMML/ODFW[2]	eastern	2001-2003	2	511	0.004	0.002	3
ADFG[3]	eastern	2001-2003	14	1208	0.010	0.005	7
Pooled			*18*	*2703*	*0.007*	*0.002*	*23*

[1]National Marine Mammal Laboratory-Alaska Ecosystems Program
[2]National Marine Mammal Laboratory-California Current Program/Oregon Department of Fish and Wildlife
[3]Alaska Department of Fish and Game

Table 3. Summary of studies in which branding was used on pinnipeds.

Species	Year	# pups	# other	Where	hot/freeze	Who
Steller sea lion	1977-present	>16,000	>300	throughout range	hot	NMML, ADFG, Russians
CA sea lion	1987-present	>5,000		San Miguel	hot	Melin et al.
CA sea lion	1980-1982	97	0	Baja CA	hot	Aurioles et al.
New Zealand sea lion	2000	300	135	New Zealand	hot	Wilkinson et al.; Duigan et al.
Northern fur seal	1912; 1960s-70s	>50,000	variable	Pribilof Islands	hot and freeze	FSI; Erickson et al.
New Zealand fur seal	1994	20	0	Otago Peninsula, New Zealand	freeze	Boyle et al.
New Zealand fur seal	1992-1993	0	19 adult males	Kangaroo Island, South Australia	1992-freeze 1993-hot	Troy et al.
Cape fur seal	1947-1948	600	600	??	hot	Carrick and Ingram
Southern elephant seal	1993-2000	>14,000	0	Macquarie Is., Tasmania	hot	van den Hoff et al.; Gales
Southern elephant seal	1951-1961	4,910	?	Macquarie	hot	Csordas
Southern elephant seal	1949-1953	1,486	0	Heard Is.	Hot	Csordas
Southern elephant seal	1929	?	?	South Georgia	hot	Mathews 1929 (in Csordas)
Southern elephant seal	1945-1947	several	0	Campbell is.	hot	Sorenson (in Csordas)
Southern elephant seal	1949-1953	>1,400	48	Heard Is.	hot	ANARE (in Csordas)
Weddell seal	1932	243	243	??	Hot	Lindsay (in Csordas)
Gray seals	1963-1989	4,448	0	Sable Is.	hot	Beck et al.; Schwarz and Stobo
Ringed seals	1971	0	121	Herschel Is., Yukon	hot (electric and forge)	Smith et al.

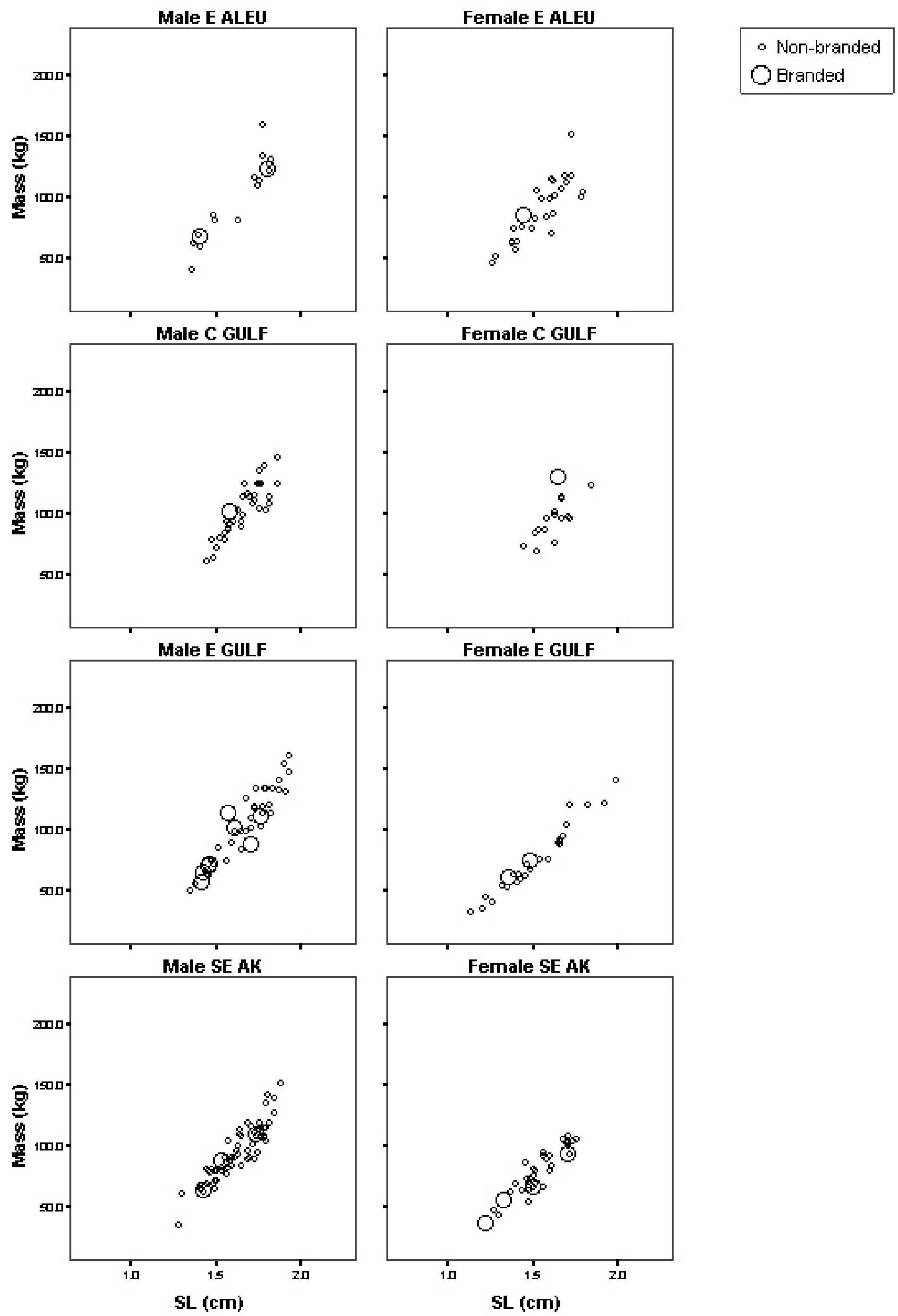
FIGURE LEGENDS

Figure 1. Mass at age of sea lions branded as pups compared to non-branded sea lions by sex and natal (branded) or capture (non-branded) region. Combined ADF&G and NMML data of juveniles captured with hoop net or underwater noose.

Figure 2. Standard length (SL) at age of sea lions branded as pups compared to non-branded sea lions by sex and natal (branded) or capture (non-branded) region. Combined ADF&G and NMML data of juveniles captured with hoop net or underwater noose.

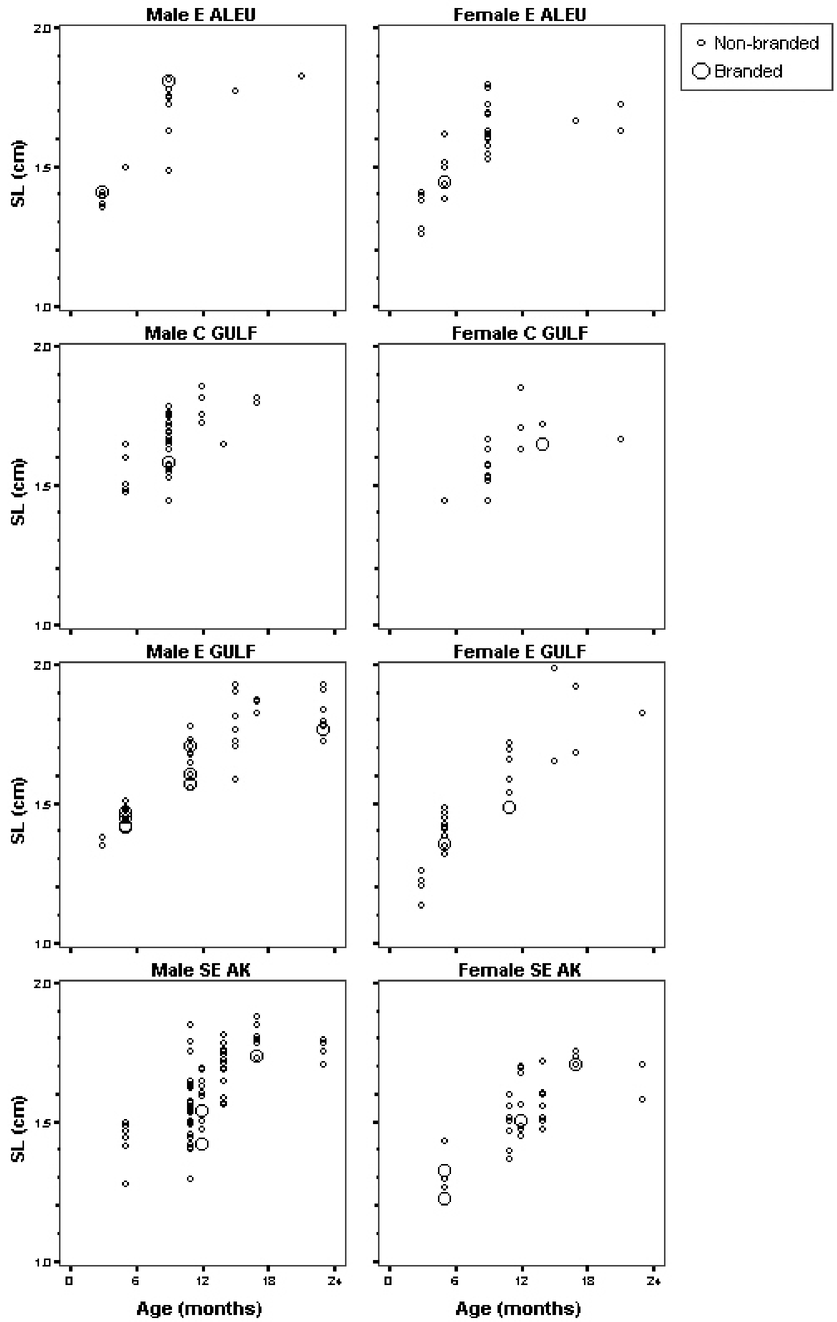
Figure 3. Standardized residuals of mass (log transformed) analysis of covariance with sex, branding status, and region as factors, and age as covariate. There was no significant effect of branding on mass at age (ANCOVA $F_{(1,370)}=0.008$, $P=0.931$).

Fig. 1



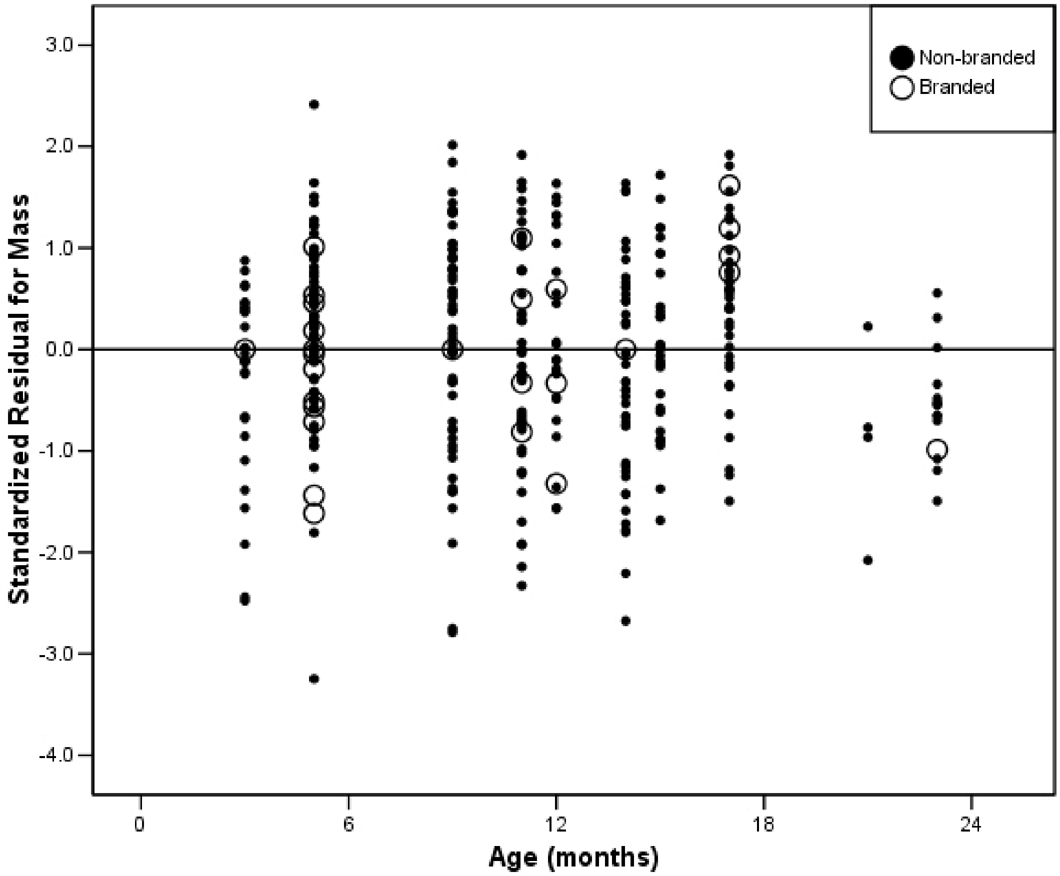
Male E ALEU
Female E ALEU
Non-branded
Branded
Male C GULF
Female C GULF
Male E GULF
Female E GULF
Male SE AK
Female SE AK
Mass (kg)
200.0
150.0
100.0
50.0
1.0
1.5
2.0
SL (cm)

Fig. 2



Male E ALEU
Female E ALEU
Non-branded
Branded
Male C GULF
Female C GULF
Male E GULF
Female E GULF
Male SE AK
Female SE AK
SL (cm)
2.0
1.5
1.0
0
6
12
18
24
Age (months)

Fig.3.



Non-branded
Branded
Standardized Residual for Mass
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
0
6
12
18
24
Age (months)