

**Draft Framework for FY2001 Steller Sea Lion Research
(Alaska Fisheries Science Center)**

The FY2001 appropriations language identifies a total of \$43.2 million in the NOAA budget for the implementation of Steller sea lion protective measures. This constitutes a very large increase of over \$36.8 million for Steller sea lion research and management. Recipients of the funding include NMFS, OAR, NOS, North Pacific Fisheries Management Council, State of Alaska, University of Alaska, Alaska Sea Life Center, and the North Pacific Universities Marine Mammal Research Consortium. The collective expertise of these organizations, supported by these new appropriations, provides an opportunity to significantly increase our knowledge of the Steller sea lion decline and to identify the most effective means of meeting conservation and management goals under both MSFCMA and ESA. However, the breadth of the Steller sea lion research questions, and the large number of research participants suggest that early and ongoing coordination of programs will be needed to effectively address the problem as specified by Congress. Recognizing that plans for the 2001 field season need to be developed immediately, and drawing upon the AFSC experience with Steller sea lion biology/management issues, we offer the following draft framework for potential research project development as a starting point for discussions among the endowed parties. This approach specifically incorporates all of the topics of interest expressed in the appropriations language (Secs. 209(a)(2) and 209(d)) in a format that will allow participants clarify the relationship between the primary research questions and the various component projects necessary to answer them.

The draft framework (Table 1) consists of 3 elements:

1. Identification of the principle hypotheses (causal factors) related to the Steller sea lion decline. These are extracted from the appropriations language.

Noting that the western population of Steller sea lions has declined substantially over the last 25 years, Congress has directed that a broad research program be conducted to examine "all possible factors relating to such decline, including the possible interactions between commercial fishing and Steller sea lions and the localized depletion hypothesis"(Sec. 209(a)(2)). The intended scope of this research effort is further specified in Section 209(d) where a collection of 12 topics are listed:

(d) SEA LION PROTECTION MEASURES.-\$20,000,000 is hereby appropriated to the Secretary of Commerce to remain available until expended to develop and implement a coordinated, comprehensive research and recovery program for the Steller sea lion, which shall be designated to study—

- (1) available prey species;*
- (2) predator/prey relationships;*
- (3) predation by other marine mammals;*
- (4) interactions between fisheries and Steller sea lions, including the localized depletion theory;*
- (5) regime shift, climate change, and other impacts associated with changing environmental conditions in the North Pacific and Bering Sea;*

- (6) *disease;*
- (7) *juvenile and pup survival rates;*
- (8) *population counts;*
- (9) *nutritional stress;*
- (10) *foreign commercial harvest of sea lions outside the exclusive economic zone;*
- (11) *the residual impacts of former government-authorized Steller sea lion eradication bounty programs; and*
- (12) *the residual impacts of intentional lethal takes of Steller sea lions.*

Although these twelve items are specifically referenced to the \$20 million appropriated for sea lion protective measures, they identify topics that relate to the entire research effort. While the list points out various “things to study”, it is also problematic in that it contains both categorical areas of research and individual topics that relate to one or more categories. For instance, a regime shift (5), could precipitate nutritional stress (9), manifested by changes in juvenile and pup survival rates (7). Nonetheless, with slight interpretation, the list provides the starting point for the research framework. Five principle hypotheses for the Steller sea lion decline were distilled from the 12 items in the appropriations language:

1. fisheries competition (item 4);
2. environmental change (item 5);
3. predation (item 3);
4. anthropogenic effects of disturbance/intentional mortality/harvests (items 10,11 and 12); and
5. disease (item 6);

A 6th principle, pollution, was also added to our list. Each of these are listed in the first column of the draft framework. The second column lists the various ways in which the general categories of causation expressed by the principle hypotheses might result in adverse impacts to steller sea lions (i.e. the vectors). We suggest that these vectors be discussed and carefully articulated because they constitute different research orientations and designs.

These six principle hypotheses then form the overall headings under which more specific research questions fall. Thus, the second step is:

2. Expansion of the general hypotheses into individual research questions that represent the vectors through which the interaction between the causal factor and the Steller sea lion may occur.

Each hypothesis contains multiple pathways or vectors by which impacts on Steller sea lions may manifest themselves. For instance, fisheries competition could effect Steller sea lion foraging success either by altering prey abundance (e.g. globally or locally) or by disturbance of prey fields (e.g. via redistribution or changes in density). This would be the appropriate context to address how such modifications of habitat (natural or anthropogenic) relate to other elements on the list such as nutritional

stress or changes in survival or reproduction.

Articulation of the many research directions underlying each causal element category is a prerequisite to their prioritization and consideration of feasibility. To help determine feasibility and to move closer to the development of proposals or spending plans, the third step in the framework is necessary:

3. List the research project elements that would be required to address each of the questions posed in the previous step.

The building blocks needed to fully address each pathway or vector are represented by the set of individual research elements supporting the projects. In nearly every case, all proposed studies will ultimately involve additional research on either Steller sea lion biology or the habitats (both physical and biological) that influence their recovery. It is likely that much of the work identified under one hypothesis could contribute to testing other hypotheses and this step will help to identify opportunities for research plan integration among the participants.

Overall, the development of a framework such as the one proposed will help participants identify aspects of an overall research program that their resources and expertises are most suited to address. Using this framework as a starting point, we hope to encourage the participants to contribute to the full development of a comprehensive and coordinated research program. Further, agreement on the overall context of the research effort will encourage cooperation and avoid duplication of effort.

Table 1. Draft Framework for FY2001 Steller Sea Lion Research (Alaska Fisheries Science Center)

Principle Hypotheses	Vectors	Research Project Elements
<p>1. Fisheries Competition</p>	<p>V1 - <i>Removals of prey</i> by commercial fisheries reduce the abundance/availability of prey on the global scale (i.e., FMP area or ecosystem wide)</p> <p>V2 - <i>Removals of prey</i> by commercial fisheries reduce the abundance/availability of prey at local scales of relevance to foraging Steller sea lions</p> <p>V3 - <i>Disturbance of prey fields</i> by commercial fisheries reduce the availability of prey by reducing patch densities</p> <p>V4 - <i>Disturbance of prey fields</i> by commercial fisheries reduce the availability of prey by redistribution of prey patches</p>	<p>V1 Project Elements: Requires expanded knowledge of a) prey base, stock dynamics (i.e. spatial/temporal distributions, seasonal movement patterns, factors effecting predation, survival and productivity), b) effects of fisheries removals on the prey base (recognizing these dynamics) and Steller sea lion response to associated differences in prey availability.</p> <ul style="list-style-type: none"> - Improve ability to assess Atka Mackerel, GOA Pollock, GOA Pacific cod - Develop an ability to assess forage species for the BSAI and GOA - Improve catch monitoring for groundfish vessels less than 125 feet - Develop methods for monitoring catch of forage fish at the species level species reference points - Develop and update ecosystem models indicators of the GOA and BSAI ecosystems - Expand studies of predator/prey interactions AND Update analysis of existing samples for predator/prey models - Improve knowledge of the role of oceanographic factors on large scale fish distribution - Improve knowledge of the role of oceanographic factors on fish production on fecundity and maturity of groundfish species

		<ul style="list-style-type: none"> - Develop multi-species biological reference points and evaluate impacts relative to single- - Improve knowledge of the impact of gear allocations on fish distribution and abundance - Improve knowledge of the impact of fisheries - Implement seasonal resource surveys - Design and implement tagging projects to improve knowledge of seasonal Pacific cod and Atka mackerel movements - Update and develop new multi-species seasonally explicit predator/prey models - Design and Implement seasonality studies in regions of contrasting Steller sea lion abundance trends <p>V2 Project Elements:</p> <ul style="list-style-type: none"> - Design and implement resource surveys to determine the impact of fisheries on local groundfish abundance and distribution - Conduct studies to examine the densities of fish utilized by commercial fishermen and Steller sea lions - Determine the role of oceanographic conditions availability at the local scale - Determine the availability and ecosystem utilization of fish-prey at the local scale - Improve, update and develop new spatially explicit multi- species models
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<p>2. Environmental Change</p>	<p>Theme: changes in K</p> <p>V1. Changes in primary production have lead to conditions which effect Steller sea lion survival or reproductive capability</p> <p>V2 <i>Changes in the physical environment</i> have lead to conditions which effect Steller sea lion survival or reproductive capability</p> <p>V3 <i>Changes in species composition</i> have lead to conditions which effect Steller sea lion survival or reproductive capability</p>	<p>V1 Project Elements - Correlate changes in the life history of steller sea lions based on collections made in the 1970s and 1980s with features of the physical and biological marine environment from the same period</p> <p>V2 Project Elements - Correlate changes in the life history of steller sea lions based on collections made in the 1970s and 1980s with features of the physical and biological marine environment from the same period</p> <p>V3 Project Elements - Correlate changes in the life history of steller sea lions based on collections made in the 1970s and 1980s with features of the physical and biological marine environment from the same period</p> <p>Notes: time series late 70's to present; requires Stellers branding project for contemporary vital rate data modeling: ECOSYM, ECOPATH moorings, drifters diet diversity trends (longitudinal across range of w. stock; re-analysis of diet diversity data</p>

<p>3. Predation</p>	<p>V1 Predation by <i>killer whales</i> has a) increased as a function of their increased populations or per capita predation rates and is contributing significantly to their decline or b) remained constant but has increasing effect at lower Stellers population levels.</p> <p>V2 .Predation by <i>sharks</i> (sleeper or salmon) has a) increased as a function of their increased populations or per capita predation rates and is contributing significantly to their decline or b) remained constant but has increasing effect at lower Stellers population levels.</p>	<p>V1 Project Elements Killer whale studies - population trends and abundance - diet (% Stellers) -free fatty acid signature (Stellers in killer whales) - direct observation - distribution and movements, especially with respect to activity near rookeries</p> <p>V2 Project Elements shark studies - population trends and abundance - stomach sampling (longline fishery for large sleeper sharks off sea lion rookeries Aug-Oct 01 and Mar-May 02)</p> <p>- direct observation? - live predation vs scavenging</p>
<p>4. Anthropogenic Effects of Disturbance/ Intentional Mortality/Harvests</p>	<p>V1 One or more sources of <i>anthropogenic disturbance</i>, including direct mortality, harvesting, incidental take and intentional killing lead to and continue to contribute to the ongoing Steller sea lion decline</p>	<p>V1 Project Elements -retrospective summary of removals from all sources by year, by area prior to the onset of the decline - modeling of population responses given combinations of sources - effects of disturbance as it translates to decreased reproductive capacity or increased mortality</p>
<p>5. Disease</p>	<p>V1 Disease has reduced the reproductive capacity of steller sea lions</p> <p>V2 Disease has increased the mortality of Steller sea lions</p>	<p>V1 and V2 Project Elements - antigen analyses of tissues (via 1 time biopsy or carcass sampling) - longitudinal studies of branded animals (blood, and biopsy) -contaminant pathways - risk analyses - contrast SE w/ GOA w/ BS</p>

6. Pollution	V1 Pollutants have reduced the reproductive capacity of steller sea lions V2 Pollutants have increased the mortality of Steller sea lions	V1 and V2 Project Elements -contaminant analyses of tissues (via 1 time biopsy or carcass sampling) - longitudinal studies of branded animals (blood, and biopsy) -contaminant pathways - risk analyses - contrast SE w/ GOA
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