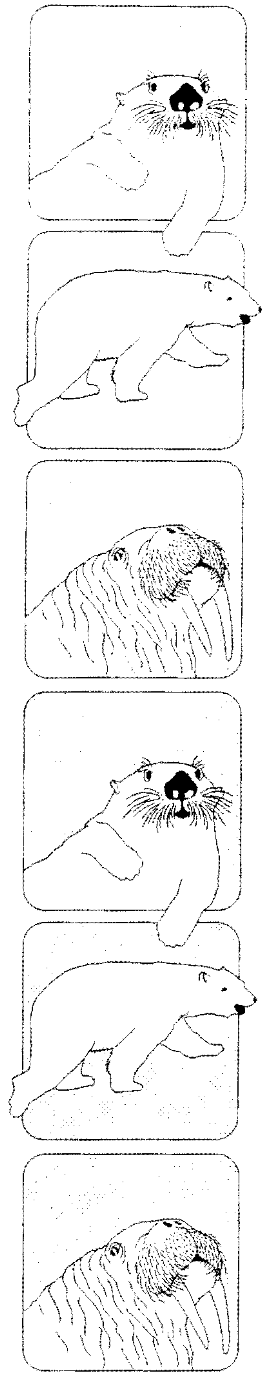
SEA OTTER CONSERVATION: REPORT FROM THE SIXTH JOINT U.S. - RUSSIA SEA OTTER WORKSHOP



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Fish and Wildlife Service
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SEA OT R CONSERVATION:

REPORT from the Sixtl int US - Russia Sea Otter Workshop

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Forl Vashington, USA

By

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PREFACE: **World Sea Otter Conservation**

Currently, core populations of sea otters (*Enhydra lutris*) are found in waters adjacent to the Pacific rim nations of Canada, Russia, and the United States of America. They once lived in waters off Japan and Mexico as well. Piecing together earliest historic records, scientists estimate the world population of sea otters may have exceeded 150,000 in the mid-1700s.

Early fur hunters push sea otters toward extinction
Starting in 1740 and ending in 1911, the greatest threat to sea otters was efficient hunters from the North America, Russia, Spain, France, and Mexico seeking the highly prized fur pelts. By the early 1900s, sea otters were nearly extinct. Less than 2,000 sea otters probably remained when they were finally protected from hunting.

Treaty starts international protection
Cooperative international efforts to protect the sea otter began with the signing of the 1911 North Pacific Fur Seal Convention by Great Britain (for Canada), Japan, Russia, and the United States. Fearing imminent extinction, the treaty nations extended complete protection to sea otters. Cessation of hunting, as well as habitat protection and translocations, together allowed the sea otter to increase in abundance and reclaim much of its historic range.

Individual nations also continue to protect sea otters in their coastal waters. The following is a summary of protective measures and status.

United States
In the United States, the Marine Mammal Protection Act (MMPA) and the Endangered Species Act provide enforceable requirements to protect sea otters from exploitation. Under the MMPA, Alaska Natives are allowed to hunt sea otters for subsistence uses including food and traditional handicrafts. They hunt sea otters primarily to use their pelts.

In California, the southern sea otter *(Enhydra lutris nereis)* is classified as "threatened" under the Endangered Species Act, "depleted" under the MMPA, and as a "fully protected mammal under California state law. In Oregon and Washington, state regulations list the sea otter as "threatened"and "endangered," respectively. A Native tribe in Washington is petitioning for hunting rights.

Russia
Russia's sea otters are not identified as endangered, but they are listed in the Russian Red Data Book as a Category 5 population: one that has not recovered to previous levels. That "threatened" status was reconfirmed in 1997. Commercial and subsistence hunting of sea otters is prohibited. Poaching is a current concern.

Canada
In Canada, the sea otter was downlisted in 1996 from "endangered" to "threatened" by the Canadian Committee on the Status of Endangered Species of Wildlife. Sea otters in Canada are protected by both the Federal Fisheries Act and the British Columbia Wildlife Act.

Mexico

In Mexico, the Official National Book (Diario Oficial de la Federacion) lists the sea otter as "endangered" and "endemic" in Baja California waters. It is illegal to capture, kill, or possess their products .

US/Russia Environmental Agreement opens door for scientific cooperation

Since the signing of the US - USSR Environmental Agreement in 1972 (renegotiated in 1994 as the US - Russia Environmental Agreement), US and Russian conservation agencies and other organizations have recognized the importance of sharing scientific information. The two nations have sponsored more than a thousand exchanges of American and Russian specialists in rare and endangered fauna and flora, refuges and reserves, migratory birds, marine mammals, fish husbandry, and terrestrial/marine ecosystem biodiversity. Many species of plants and animals found in these two nations are either related or very similar.

The primary goal of the US - Russia Environmental Agreement is to foster conservation of individual species or groups of species and their habitats. Biologists from both countries exchange expertise and collaborate in field studies to add to the body of scientific knowledge and point the way to more effective management. Even during uneasy political times of the 1970s and 1980s, biologists in Russia and the United States were able to meet and exchange information and ideas.

Sea otters benefit; workshop exchange begins in 1984

Under the auspices of the Environmental Agreement, sea otter biologists, managers, and researchers from the United States and Russia jointly sponsored workshops from 1984 through 1995:

1984 - First joint workshop on sea otter biology, Nakhodka, Russia
    10 Russian and 5 US participants
1989 - Second joint workshop on sea otter biology, Pt. Piedras Blancas, California, USA
    3 Russian and 18 US participants
1991 - Third joint sea otter conference, Petropavlovsk, Russia
    17 Russian and 6 US participants
1993 - Fourth joint workshop on sea otter biology, Wasilla, Alaska, USA
    7 Russian and 26 US participants
1995 - Fifth joint workshop on sea otter biology, Paratunka, Russia
    16 Russian and 7 US participants, 1 Japanese observer

Invitation to sea otter specialists throughout its world range

At the fifth workshop, participants identified a need to include biologists from all nations in the sea otter's range to talk about issues of mutual interest. Subsequently, the sixth joint workshop (subject of this document) included participants from four nations:

1997, Sixth joint workshop on sea otter biology, Forks, Washington, USA
    8 Russian, 38 US, 2 Canadian, and 3 Japanese participants

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Sixth Joint US - Russia Sea Otter Workshop Report
November 1997

ACKNOWLEDGMENTS

The Sixth Joint US - Russia Sea Otter Workshop was organized by Alexander M. Burdin (Russia), Carol S. Gorbics (USA), Michelle M. Staedler (USA), and Glenn R. VanBlaricom (USA). Special thanks to Peter B. Ward for his assistance; Matthew Wood and Sarah Peyton, translators at the workshop; and Elaine Rhode, report editor.

INTRODUCTION: **Joint US - Russia Sea Otter Workshop**

For the first time in one location, people responsible for working with sea otters throughout their range came together in a gathering of four nations at the Sixth Joint US - Russia Sea Otter Workshop, November 9-14, 1997, in Forks, Washington, USA. See **Appendix B** for the list of participating organizations.

The workshop provided a unique opportunity for participants to compile comprehensive sea otter information, discuss its implications, and suggest future needs for action.

Goals of the workshop

- To facilitate exchange of information
- To share knowledge on sea otter biology
- To share knowledge on population status and trends
- To provide opportunity for exchange of biological material
- To share information on local and regional use of sea otters

Technical Focus of Workshop

Thirty-six technical presentations focused on four topics of sea otter conservation:

I. Sea Otter Population Status and Trends
II. Sea Otter Ecology and Resource Interactions
III. Sea Otter Health Status, Genetics, and Mortality
IV. Captive Sea Otter Biology and Husbandry

Abstracts of Presentations

See **Appendix C** for abstracts of the 36 presentations. The summaries of the Russian presentations have more detail (reconstructed from workshop notes) than the other abstracts as a service to readers who may not have access to Russian publications.

Working Group Reports and Recommendations

Participants also formed Working Groups on the four focus topics to compile known information and explore areas needing future research. The following sections contain the reports from each Working Group.

TOPIC I: **Sea Otter Population Status and Trends**

Working Group Report - Carol Gorbics

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Nadezhda Zimenko, KamchatNIRO, Russia
Ilya Shevchenko, KamchatNIRO, Russia
M. Tim Tinker, Glenside Ecological Services, Canada
Kaoru Hattori, Hokkaido University, Japan

Introduction

The working group on Sea Otter Population Status and Trends focused on the collective knowledge of sea otter distribution, abundance, and trends throughout its world range. As a convenient reference, workshop presentations pertaining to this topic are listed at the end of this chapter. For the text of the abstracts, see Appendix C.

World Abundance of Sea Otters

Several workshop reports presented the most current data on sea otter abundance in specific parts of their range. Additionally, several participants provided up-to-date results of national abundance surveys. A summary of this information yields a world sea otter population estimate of greater than 125,000 animals (**Table 1**, Appendix A). The Working Group believes this is a minimum estimate because many of the surveys did not incorporate a correction factor for unseen animals.

Threats to Regional and World Sea Otter Abundance

Several reports addressed regional issues of concern that could adversely affect sea otters or their habitat. This information, along with recommendations for action, was compiled and summarized by region (**Table 2**, Appendix A). The following issues were identified:

A. ***Poaching:*** Russian scientists expressed concern that poaching may be adversely influencing sea otter population growth and distribution in Russian waters. They believe poaching occurs throughout the range of the sea otter in Russia with a take of perhaps as many as 200 to 300 animals per year. They reported a black market existing within Russia that illegally exports pelts to China, Korea, and Japan. No efforts were underway to monitor or regulate these unauthorized activities. *(see* Burdin)

B. ***Contamination including oil spills:*** Contamination from a variety of sources in a variety of locations has been reported in sea otter tissue and habitat. Oil spills have affected sea otters in Alaska, Washington, and California. The threat of oil pollution in British Columbia and Russia was reported to be less. The effects of the *Exxon Valdez* oil spill in Alaska may still be influencing sea otters on a population level more than 10 years after the event (*see* Monson *et al.*; Gage and VanBlaricom). Although two spills in Washington impacted sea otters, abundance in that region has continued to increase since animals were translocated there in 1969 (*see* Jameson *et al.*). Other sources of contaminants identified by workshop participants included nuclear wastes (Russia), volcanic eruptions (Russia), and military sites (*see* Tinker; Gorbics; Burdin).

C. ***Shipping:*** Shipping and ship traffic was listed as a potential concern in all nations. Oil tankers and fuel barges travel throughout the sea otter's range. In addition, potential spills from the fuel tanks and chemicals aboard cargo and fishing vessels also pose a risk to sea otters in nearshore habitats.

D. ***Military pollution:*** Active and abandoned military sites throughout Alaska and Russia were identified as potential point sources of pollution that could cause localized adverse impacts on sea otter population abundance.

E. ***Fisheries conflicts:*** Fisheries conflicts in the United States, Canada, and Russia continue to be a cause of concern. In Alaska, some efforts have been made to monitor fisheries and record the number of sea otters killed or injured due to gear interaction. Low numbers of documented deaths (range 0 to 8 per year) have been reported. In California, entanglement and drowning of sea otters in gill and trammel nets have been cited as a serious cause of mortality. Little information is available on conflicts between sea otters and Russian fisheries.

The Working Group recommended that issues related to fisheries conflicts receive greater research emphasis in the future.

F. ***Predation:*** Although sea otters are near the top of the food chain, great white sharks, killer whales, and brown bears are believed to prey on adult sea otters. Between 1968 and 1992, approximately 8 percent of California sea otter carcasses inspected exhibited strong evidence of wounds made by great white sharks (*see* Ames *et al.*). Killer whale predation on sea otters has been infrequently reported in the past. It was postulated that increased mortality in the sea otter population near Adak Island, Alaska, and other nearby Aleutian Islands may be caused by predation by killer whales (*see* Tinker and Estes). Brown bears at Cape Lopatka *[м. Лопатка]*, Russia, have been observed preying on sea otters hauled out on beaches. Approximately 15% of the mortality at Cape Lopatka is attributed to brown bear predation. Such bear behavior has not been reported in other areas of the sea otter's range (*see* Kornev).

Workshop participants suggested that predation as a cause of significant mortality may have been overlooked in past research.

G. ***Ecological shift in Bering Sea:*** Workshop participants discussed the hypothesis that causes of population declines in the Aleutian Islands may be due to an ecological shift in the Bering Sea ecosystem.

The Working Group recommended that additional research be done in the Bering Sea ecosystem.

H. ***Harvest:*** Harvest of sea otters by Alaska Natives has averaged 809 sea otters for the last five years *(see* Gorbics). Legal harvest does not occur in other parts of the sea otter's range. Workshop participants cited the potential future harvest of sea otters by the Makah Indian tribe in Washington.

I. ***Disease:*** Disease may cause up to 40 percent of the mortality of California sea otters. Disease factors include parasites, bacteria, and fungal infections *(see* Thomas). Pathogen exposure was evaluated for sea otters in California and Alaska *(see* Hanni *et al.*).

The Working Group recommended that diseases in sea otters continue to be evaluated, particularly in areas where populations are declining or are of unknown status.

Regional and World Conservation Actions for Sea Otters

1. **Implement and enforce regulations to protect sea otter populations and habitat.** International regulations (North Pacific Fur Seal Convention of 1911 *[commonly called the Fur Seal Treaty]*), and national regulations such as in the United States (Marine Mammal Protection Act of 1972 as amended and the Endangered Species Act) and Canada (Provincial Wildlife Regulations and Federal Fisheries Regulations) have provided a reasonable conservation framework under which sea otter numbers have generally increased throughout their world range. Similar national laws and regulations to protect sea otters are needed in Russia. Enforcement of regulations everywhere is problematic due to lack of money and personnel, however, it is of particular concern in Russia waters.

Workshop participants recommended that additional efforts need to be made to reduce poaching.

2. **Advocate selected fisheries closures.** Workshop participants discussed various solutions to the problem of lethal commercial fisheries interactions with sea otters.

The Working Group recommended that certain areas should be closed to fishing, particularly where lethal interactions were documented and adversely affecting the population.

3. **Identify contaminant clean-up needs.** The main contaminants of concern are hydrocarbons, organochlorine pesticides, and industrial chemicals (e.g., PCBs-polychlorinated

biphenyls). Evidence of organochlorine contamination in sea otters has been documented in Alaska and California; it is suspected to be present in Russia. Radioactive contamination from nuclear weapons testing and releases from European power plants are also of concern, particularly in Russia *(see* Burdin). An understanding of contamination pathways is essential to target clean-up efforts effectively.

Additional efforts need to be made to identify sources of contamination in the sea otter's environment and document the extent of the problem.

4. **Encourage sustainable harvest.** Sea otter harvest by Alaska Natives is the major source of the animal's direct human-caused mortality. Alaska Natives are working to encourage sustainable harvest through the development and implementation of local management plans *(see* Gorbics).

Efforts should be made to encourage the Makah Indians of Washington State to closely manage their potential future harvest to minimize adverse impacts on the Washington sea otter population.

Regional and World Research Needs

Workshop participants identified research needs, either regionally specific or common to all nations, which are shown in **Table 2**, Appendix A, and summarized below.

- Monitor the patterns of population expansion.
- Evaluate the potential conflicts with commercial fishing.
- Standardize methods to estimate population abundance throughout the sea otter's range.
- Monitor the population status (stable, increasing, or decreasing) for all stocks and populations.
- Intensively study declining populations to determine the causes of the decline.
- Monitor and evaluate the pathway, tissue load and physiological effects of pollutants in the environment.
- Examine the effects of sea otters on their habitat, particularly soft-bottom habitats.
- Evaluate disease in wild populations of sea otters.
- Standardize methods for evaluating body condition, health, and morphometric measurements.

Identify Measures to Understand International Boundaries as They Relate to Stock Boundaries

Workshop participants cited the need to understand if and how regional and national sea otter stocks interact. Movement of animals across international boundaries is currently unlikely due to the sea otter's near extirpation and continued reduced distribution. Workshop participants agreed, however, that as populations expand, sea otters in Canada and the United States may interact across the Alaska-British Columbia-Washington borders. Researchers should be prepared to detect, monitor, and study future interactions.

NOTE: Also refer to the following abstracts of workshop presentations in Appendix C:

Burdin, A. M. Status of sea otter populations in Russia.

Gorbics, C. S. Summary of sea otter (*Enhydra lutris kenyoni*) survey results in Alaska, USA.

Gorbics, C. S., and Bodkin, J. L. Stock identity of sea otters (*Enhydra lutris kenyoni*) in Alaska, USA.

Hatfield, B., and Jameson, R. J. Status of the California (USA) sea otter population as indicated by recent surveys and mortality patterns.

Hattori, K. Sea otters on the East Coast of Hokkaido, Japan.

Jameson, R. J., Jeffries, S., and Kenyon, K. W. Status and trends of the Washington, USA, translocated sea otter population.

Kornev, S. I. Results of sea otter surveys on Southern Kamchatka *[п-ов Камчатка]* and Northern Kuril Islands *[Курильские о-ва]*, Russia, in June 1997.

Kornev, S. I. Results of long term monitoring of sea otters in Southern Kamchatka (Cape Lopatka - *м. Лопатка*), Russia.

Maminov, M. K. Status of the sea otter population on the Kuril Islands *[Курильские о-ва]*, Russia.

Nikulin, V. S. Results of sea otter tagging on Kamchatka Peninsula *[п-ов Камчатка]* and Commander *[Командорские о-ва]* and Kuril Islands *[Курильские о-ва]*, Russia, in 1996 and 1997, and future perspectives.

Tinker, M. T., and Estes, J. A. Sea otter population decline in Alaska's Western Aleutian Islands, USA: An overview of trends, effects, and possible causes.

VanBlaricom, G. R., Burdin, A. M., Gerber, L. R., and Rubin, R. D. Estimation of pre-exploitation sea otter population sizes in the Northwest Pacific Ocean using archival harvest data and modern population growth data.

Vertenkin, V. V. Sea otters of Ytashud Island *[о. Уташуд]*, Kamchatka Peninsula *[п-ов Камчатка]*, Russia.

Watson, J., Ellis, G., and Ford, K. B. Population growth and expansion in Canada's British Columbia sea otter population.

TOPIC II: **Sea Otter Ecology and Resource Interactions**

Working Group Report - Glenn VanBlaricom

Working Group Participants
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Denise Daily, Makah Tribe, USA
Steve Jeffries, Washington Department of Fish and Wildlife, USA
Dan Monson, US Geological Survey, Alaska Biological Science Center, USA
Glenn VanBlaricom, Washington Cooperative Fish and Wildlife Research Unit, USGS - Biological Resources Division, University of Washington, USA

Introduction

This Working Group focused on the collective knowledge of sea otter ecology and resource interaction represented in the gathering of the Sixth Joint US - Russian Sea Otter Workshop. As a convenient reference, the list of workshop presentations pertaining to this topic is included at the end of this chapter. For text of the abstracts, see Appendix C.

The Working Group looked for areas of sea otter research (1) that would benefit from improved standardization or coordination across international boundaries or nationally; and (2) that may have broad conceptual or management interest among all nations with sea otters populations if pursued regionally.

This Working Group focused on the following (listed below in no priority order):

- Comparative studies of sea otter habitats in all nations;
- Standardization of the study of ecology and resource interactions of sea otters in all nations;
- Evaluation of the interaction of sea otters with subsistence harvests and with resources, both tribal and non-tribal.

Each topic was addressed (a) by comparing the importance of the issue to other research needs and issues, (b) by identifying possible methods for resolution of the issue, and (c) by proposing coordination of research activity in both conceptual and administrative terms.

Comparative Studies of Sea Otter Habitats in all Nations

1. **Standardizing techniques.** Methods used in studies of sea otter ecology in the western Aleutian Islands, Alaska, USA, have been applied across a wide range of geographic locations within North America. Russian studies of similar issues in that nation's Commander Islands *[Командорские о-ва]* generally have used quite different techniques in all aspects of sea otter research.

> **Given the clear physiographic and ecological similarities between the western Aleutian and Commander Island groups, the Working Group recommended standardizing research techniques for work done in the two locations.**

2. **International sampling team.** Researchers on all sides of the North Pacific have conducted a number of studies of sea otter diet and foraging ecology. Comparison and integration of these studies are difficult, however, because of three uncontrolled variables: habitat type, technique for data collection, and observer.

The Working Group recommended a series of international grouped samples: a given team of observers would gather data on diet and foraging patterns using consistent methods in locations as similar as possible in habitat type in the USA, Canada, and Russia (expandable to include Japan and Mexico, should significant sea otter populations develop).

For example, a particular group of experienced observers might use ground-based, optical focal-animal sampling to gather dietary data on sea otters using bays with sedimentary substrata in each of the three countries. Such studies would facilitate more useful comparison of data from different research teams or from different methods.

3. **Limiting factors.** Studies of the effects of sea otters as top-level carnivores in coastal communities typically have been done where food supply has been the apparent limiting factor for sea otter abundance. Locations seem rare where factors other than food play a significant role in limiting sea otter numbers.

Based on preliminary observations by Russian investigators, the Kronotski region *[Кроноцкий з. и м.]* of Kamchatka Peninsula's southeast coast may be one of those rare locations. At Cape Kronotski, periodic late winter development of sea ice may force resident sea otters to leave the area for a significant time. Ice development, therefore, may be a periodic natural disturbance that may regulate sea otter density. Because the general paradigm of sea otter - ecosystem interaction is based on the premise of food limitation of sea otter numbers, the Kronotski situation may represent an alternative scenario wherein the dynamics of sea otter populations are not linked deterministically to benthic community structure and function.

The Working Group recommended studies of sea otter diet, sea otter distribution and abundance by season, patterns of ice cover, and benthic community structure in the Kronotski region. Such studies would help assess the relative importance of natural disturbance versus food web interactions in regulating the biological structure of coastal benthic communities.

Strengthening Protocols for Studies of Sea Otter Ecology and Resource Interactions

1. **Standardizing research protocols.** As discussed in (1) and (2) above, a study's method, observer, and habitat configuration can bias results and restrict comparability.

The Working Group urged the standardization of techniques and sampling protocols among investigators in all countries with sea otter populations.

2. **Bathymetric scope of studies.** Field studies of benthic communities and prey populations of sea otters usually are limited in bathymetric extent. Particularly in recent years, for example, the systematic benthic surveys done by US investigators rarely sample at depths greater than 12-15 m, the limit for efficiency and safety in SCUBA techniques used in the majority of this research. Sea otters are known to be capable of dives to 100 m; and recent studies with time-depth recorders in Alaska indicate that foraging dives in excess of 50 m may be common (*see* Bodkin *et al.*).

> **Given the bathymetric bias in many existing data sets, data from greater depths are needed to evaluate the validity of the current picture of sea otter - ecosystem interactions. In addition, the possibility that prey populations use deeper habitats as refugia from the effects of sea otters needs to be investigated because of its potential implications for management of sea otter - resource conflicts.**

3. **Mortality.** The Working Group discussed sources of sea otter mortality that, with a few recent exceptions, have attracted little attention by researchers. These include new reports of significant disease incidence in California; ongoing concern about incidental take of sea otters in fisheries; harvest of sea otters by tribal members in the USA (Alaska); potential roles of natural disturbance in sea otter population dynamics; and sea otter - ecosystem interactions. The group's view on the issue of natural disturbance is summarized above under "Limiting factors."

> **The Working Group saw no current justification for significant new research in sea otter mortality beyond what already exists. The group agreed that significant new sea otter mortality discoveries, or the emergence of new management concerns, could justify increased research. For example, recent (post-Workshop) perceptions of increased mortality rates in California and the Aleutian Islands clearly warrant increased region-specific studies of mortality.**

4. **Semi-permanent observation stations.** The Working Group discussed establishment of new observation stations to monitor all aspects of sea otter ecology and conservation in particular regions across the geographic range of sea otters. The Working Group, however, did not attach high priority to this proposal. While it is recognized that geographic data gaps clearly exist for research and management issues relating to sea otters, it was believed that the establishment of fixed-location, multi-purpose observer stations was not economically or logistically practical, and that geographic gaps in data would remain even if resources could be found to support such stations.

> **The Working Group recommended that planning for research and conservation activities should continue to be driven by conceptual and management issues, with maximum flexibility in allocation of resources, rather than by geographically-fixed observation.**

Interaction of Sea Otters with Subsistence Harvests and Resources

The interaction of sea otters with subsistence harvests and resources, both tribal and non-tribal, was of particular interest to the Working Group. The group agreed that subsistence-related consumption of marine resources has not been adequately integrated into considerations of sea otter - ecosystem interactions, or sea otter - resource conflicts.

The Working Group recommended devoting research and management effort to subsistence issues. The group identified potential research questions:

- What species of coastal marine organisms are used by subsistence consumers?
- What is the degree of overlap in species consumed by sea otters and those taken by subsistence users?
- How does subsistence harvest influence the structure and function of coastal ecosystems?
- In what geographic areas are subsistence uses of coastal marine organisms most intensive?

The Working Group also agreed that studies of ecosystem-level effects of sea otters ought to be as broadly based as possible, considering all organisms affected rather than limiting study and management action to taxa of particular interest to specific user groups.

Acknowledgment: Sarah K. Carter provided helpful comments on a draft version of this Working Group report.

NOTE: Also refer to the following abstracts of workshop presentations in Appendix C:

Ames, J. A., Staedler, M. M., Hatfield, B., Geibel, J. J., Harris, M. H., Espinosa, L., Imai, R., and Muskat, J. Dead sea otter drift study, a follow-up.

Ballachey, B. E., Snyder, P. W., Bodkin, J. L., Monson, D. H., and Rebar, A. H. Bioindicators of oil exposure in sea otters.

Bodkin, J. L., and Kelly, B. P., and Esslinger, G. E. Monitoring sea otter dives with ultrasonic transmitters and time-depth recorders.

Carter, S., and VanBlaricom, G. R. Effects of sea otter predation and commercial red urchin *(Strongylocentrotus franciscanus)* harvest on nearshore ecosystems in northern Washington, USA.

Fukuyama, A., and VanBlaricom, G. R. Sea otter foraging in Prince William Sound, Alaska, USA: A benthic perspective.

Gage, T., and VanBlaricom, G. R. Competition between sea otters and predatory benthic invertebrates for bivalve prey in Prince William Sound, Alaska, USA: Implications for recovery of sea otters from the *Exxon Valdez* oil spill.

Kornev, S. I. Results of long term monitoring of sea otters in Southern Kamchatka (Cape Lopatka - *м. Лопатка*), Russia.

Monson, D. H., Bodkin, J. L., and Ballachey, B. E. Recovery of sea otters following the *Exxon Valdez* oil spill, Alaska, USA: An ecosystem approach.

Nikulin, V. S. Results of sea otter tagging on Kamchatka Peninsula *[п-ов Камчатка]* and Commander *[Командорские о-ва]* and Kuril Islands *[Курильские о-ва]*, Russia, in 1996 and 1997, and future perspectives.

Schevchenko, I. N. Daily activity time budget and prey composition of sea otters on Medny Island *[о. Медный]*, Russia.

VanBlaricom, G. R. Food consumption rates by captive wild sea otters.

Watson, J., and Estes, J. A. Changes in community structure associated with sea otter foraging in shallow rocky areas off northwestern Vancouver Island, Canada.

Zimenko, N. P. Foraging strategies of sea otters on Medny Island *[о. Медный]*, Russia.

TOPIC III: **Sea Otter Health, Genetics, and Mortality**

Working Group Report - Brenda Ballachey and Nancy Thomas

Working Group Participants
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Barbara Bodnar, The Alaska Sea Otter Commission, USA
Maureen Laughlin, Wildlife Veterinarian, California, USA
Chika Takahashi, Hokkaido University, Japan
Nancy Thomas, US Geological Survey, National Wildlife Health Center, USA

Introduction

A growing body of knowledge suggests that a number of factors affecting sea otter health may be limiting population growth and thereby affecting population status. In today's world, it may no longer be true that if a sea otter population has enough prey and enough habitat, it will thrive. Because of a variety of factors -- including contaminants, oil spills, El Niños, predator/prey shifts, poaching, and ecosystem food web changes -- a greater understanding of animal health will increase our ability to manage sea otter populations.

Drawing on the collective knowledge gathered at the Sixth Joint US - Russia Sea Otter Workshop, this Working Group accepted the task of assessing current knowledge and recommending future action to advance our understanding of sea otter health, genetics, and mortality. As a convenient reference, workshop presentations pertaining to this topic are listed at the end of this chapter. For text of the abstracts, see Appendix C.

Include Health Factors in Population Status Studies

For reasons described above, the scientific community needs to consider a wider range of factors than have been classically considered in the assessment of sea otter population status. Basic information on health of otters can be used when assessing mortality events/ecosystem shifts. A recent example is the weight-length ratios used to eliminate health concerns in the die-off of sea otters in the Aleutians.

> **The Working Group recommended that health factors be included in all studies assessing sea otter populations when these studies require handling of otters.**

Gather baseline health and monitoring data

There is an overall lack of baseline health and monitoring data to compare populations both geographically and temporally. The *Exxon Valdez* oil spill of 1989 in Alaska highlighted our lack of baseline health and contaminants data and the value such data have in solid scientific inquiry.

The Working Group emphasized the importance of gathering baseline health data and continued monitoring.

Standardize Collection and Analytical Protocols

The most critical action needed in the study of sea otter health is to standardize collection and analytical protocols. The ultimate goal is to have comparative health data on sea otter populations throughout its international range.

The Working Group urged development of standardized protocols. Where data collection methods have differed, develop conversion factors to make past data collection comparable. This is most applicable to morphometrics.

Beach-cast carcasses: recommendations for study

1. ***Organize a monitoring program for data collection:*** Necropsy of all beach-cast carcasses in adequate condition is a valuable undertaking if there is an organized monitoring program to compile data. (In California, for example, there is the California Salvage/Stranding Network; in Alaska, the cooperative Native and federal Alaska Biosampling program). The Working Group urged the formation of monitoring programs in all regions

2. ***Optimize information through sampling strategies:*** To optimize information that can be gained from necropsies, the Working Group recommended developing standardized sampling strategies. Even in circumstances where personnel time and conditions limit ability to process carcasses (for example: conditions of dark or cold; limited knowledge; limited materials), some level of effort can be made, especially with preplanning and organization, that could enhance/optimize the information obtained.

3. ***Standardize protocols:*** In California work has been ongoing since 1960s with standardized data, a standardized necropsy form; and a beached carcasses alert program. In Alaska scientists have worked with the Alaska Sea Otter Commission since 1996 to accomplish basic field or full laboratory standardized necropsies on hunter-killed otters, as well as beached carcasses as available/appropriate. In Russia, recovery of carcasses has been limited.

The Working Group recommended assisting Russian biologists with training in standardized necropsy, diagnostic, and sampling techniques.

Health Assessment Data Needs

The following data would provide a base for health assessments of sea otters and their populations.

- ♦ Morphologic measurements including weights and lengths taken in a standardized manner; aging by using teeth
- ♦ Causes of mortality
- ♦ Baseline clinical pathology, i.e. hematology and serum chemistry
- ♦ Serology - infectious disease exposures
- ♦ Immune function tests
- ♦ Genetic analyses
- ♦ Environmental contaminant exposure (methods such as P450 quantification)
- ♦ Parasites (species and levels of infestation)

The Working Group recommended that the gathering of these health data should be incorporated into ongoing sea otter studies as opportunities arise.

Tissue Banking

The Working Group recommended banking sea otter biological samples (tissue, blood). The tissue bank could be modeled after the Alaska Marine Mammal Tissue Archival Project (AMMTAP) or other tissue banking programs. The value would be increased if samples from throughout the international range were deposited for future analyses.

Recommendations to Enhance International Study and Cooperation

1. **Actions to assist in international cooperation**
   - ♦ Facilitate obtaining permits for exchange of materials.
   - ♦ Facilitate communication about standards for data collection and analysis.
   - ♦ Consider development of an internationally accessible data base. (perhaps on the Internet)
   - ♦ Continue scientific exchange at international workshops including section on health.

2. **Areas of concern or threat to populations**

   Marine environmental contaminants are a relatively new concern that may easily cross regional and international boundaries. Understanding of the extent of the problem affecting sea otters will be greatly enhanced by continued international cooperation and communication.

3. **Develop an emergency response plan**

   Scientists working in different areas of the sea otter range have observed clusters of sea otter mortality of unexplained origin in the recent past. These mortality events often occur in remote areas. In anticipation of future mortality events and recognizing that they occur with little or no notice, advance emergency planning will be valuable. Response and sampling procedures could be developed now to assist in identifying priorities and helping to delineate factors causing the mortality (two scenarios: unknown cause of mortality ==> diagnostic sampling; known cause of mortality ==> sampling for monitoring purposes).

4. **Compile a table of data needed**

   Compile a table with world subpopulations on one axis and data needs on the other axis. Fill in the cells with information already available versus no information available / data needed. A considerable amount of baseline data exist for some population (*e.g.* baseline blood data for Alaska; good information on parasites, weight lengths).

NOTE: Also refer to the following abstracts of workshop presentations in Appendix C:

Ames, J. A., Geibel, J. J., Wendell, F. E., and Pattison, C. A. White shark-inflicted wounds of sea otters in California, USA, 1968-1992.

Ballachey, B. E., Snyder, P. W., Bodkin, J. L., Monson, D. H., and Rebar, A. H. Bioindicators of oil exposure in sea otters.

Hanni, K., Staedler, M. M., Gulland, F., Estes, J. A., Williams, T. D., and Mazet, J. Tools for management: Assessment of the health of the southern sea otter (*Enhydra lutris nereis*) population and the health, survival and behavior of rehabilitated and free-ranging pups.

Larson, S., and Wasser, S. Monitoring reproductive health in sea otters.

Thomas, N. J. An update on the causes of mortality in southern sea otters.

VanBlaricom, G. R. Food consumption rates by captive wild sea otters.

Zasypkin, M. Yu. Allozyme variability in sea otters *(Enhydra lutris lutris):* Investigation of biochemistry genetics methods.

Topic IV: **Biology and Husbandry of Captive Sea Otters**

Working Group Report - Michelle Staedler

Working Group Participants
Meg Hudson, John G. Shedd Aquarium, USA
Michelle Jeffries, Monterey Bay Aquarium, USA
Yuriko Kawabe, Osaka Aquarium, Japan
Michelle Staedler, Monterey Bay Aquarium, USA
Judy Tuttle, Oregon Coast Aquarium, USA

Introduction

Presentations from experts in the field of captive sea otter biology and husbandry were for the first time included in this international gathering for the Sixth Joint US - Russian Sea Otter Workshop. This addition provided a complimentary resource on both behavioral and physiological information on sea otters. As a convenient reference, workshop presentations pertaining to this topic are listed at the end of this chapter. For text of the abstracts, see Appendix C.

Our goal was to introduce the scientific community to the public display community and the opportunities we represent. As a group, we can provide valuable sea otter management information based on the knowledge obtained through day to day husbandry and observations. We also provide diverse educational venues to disseminate scientific information to the public. This will lead to increased awareness, understanding, and conservation of the species.

Recommendations

Drawing on the collective knowledge present at the workshop, this Working Group discussed and evaluated current issues within the field of husbandry and biology of captive sea otters and made the following recommendations for action.

Cooperation among aquaria for breeding and sharing knowledge

1. ***Population management:*** The captive populations of both northern and southern sea otters are well established and growing.

> **The Working Group recommended cooperative management of the captive sea otter populations among institutions, including cooperation among facilities for housing of non-releasable sea otters. Creation of an up-to-date, easy access studbook would promote efficient breeding and eliminate the need to capture wild animals.**

2. ***Exchange of information:*** The Working Group encouraged cooperative work and sharing of information both nationally and internationally between all aquaria housing both northern and southern sea otters. Goals include:

(a) Put together a Sea Otter Husbandry Manual that is shared by all facilities, and that all facilities agree on as the appropriate way in which to care for, train, and maintain captive sea otters. *[this is underway, post-Workshop]*
(b) Develop an online e-mail communications group for quick and direct distribution of information to all sea otter caretakers. *[this has been accomplished, post-Workshop]*

3. ***International sharing of medical protocols:*** The Working Group recommended sharing of medical protocols and procedures.

Increase minimum size of facilities

Based on experience gained from working with captive sea otters, animal care providers have found that the standard minimum size for holding facilities allowed by the US Department of Agriculture (USDA) standards is too small to safely accommodate sea otters.

The Working Group recommended that current USDA standards for minimum holding requirements for sea otters be increased.

Mandatory training for staff of new facilities

Sea otters have specific requirements for healthful survival in captivity. Aquaria with long established sea otter populations have learned optimum care procedures for both the otters and the physical facility.

The Working Group urged that staff at new facilities receiving otters for the first time must have basic marine mammal knowledge and are actively pursuing the skills required to properly care for sea otters.

Standardize Sea Otter Health Care and Data Gathering

1. ***Blood:*** Develop protocols for standardizing blood collection and analysis of results. Always bank blood for future disease testing and other studies.

2. ***Necropsy:*** In the event of animals dying in captivity, collect and maintain a standard tissue data base *(see Health Working Group report)*.

3. ***Diet:*** We recommend standardization of diet protocols.

Recommendations for Future Research

Research opportunities with captive sea otters expand the opportunities to unravel some of the behavioral and physiological puzzles in understanding this marine mammal.

- Dive physiology and energetics in captive sea otters versus wild otters.
- Sensory study --how captive sea otters find prey in the substrate.
- Continue and expand reproductive and hormone work on females.
- Develop surrogate program using conspecifics for raising orphaned or abandoned sea otter pups.
- Develop hazing techniques using sound, chemical odors to keep sea otters from oil spill areas and areas with commercial fisheries. (These techniques are being developed by California Department of Fish and Game for oil spills, and can possibly be studied using captive animals.)
- Consider ecosystem effects of behavioral modification activities.
- Cognition.
- Thermal imaging heat flux.

NOTE: Also refer to the following abstracts of workshop presentations in Appendix C:

Casson, C. J. Raising a rehabilitated sea otter pup in Washington's Seattle Aquarium, USA.
Jeffries, M. Incorporating training into a husbandry program for the southern sea otter, *Enhydra lutris nereis*, at the Monterey Bay Aquarium, California, USA.
Kawabe, Y. Weight changes of sea otters in gestation period and estimating delivery day, Osaka Aquarium, Osaka, Japan.
Ramirez, K., Hudson, M., and Takaki, L. Initiation of a sea otter training program.
Staedler, M. M., Hymer, J. A., and Williams, T. D., DVM. Monterey Bay (USA) Aquarium's sea otter research and conservation program history, statistics, and release outcomes: January 1984 - September 1997.
Styers, J., Jones, M. H., DVM. International transport of sea otters.
VanBlaricom, G. R. Food consumption rates by captive wild sea otters.

Appendix A

Tables

TABLE 1. WORLD SEA OTTER POPULATION ESTIMATE, 1997

POPULATION	ESTIMATE	ACTUAL COUNT	STATUS	RATE OF CHANGE	YEAR	SURVEY METHODS	CORRECTED FOR UNSEEN ANIMALS?	FOR ESTIMATES: CONFIDENCE INTERVAL AVAILABLE?	FOR ACTUAL COUNTS: PARTIAL OR COMPLETE COUNT?	SOURCE
Japan - Cape Nossapu		1		unknown	1997	shoreline	not corrected	--	complete	Hattori, University of Hokaiddo
Russia - Kuril Islands										
Southern Kuril	2,650			unknown	1997	skiff and aerial	not corrected	no	--	Maminov, TINRO
Middle Kuril (Simushir Is only)		60		unknown	1997	skiff and aerial	not corrected	--	complete	Maminov, TINRO
N. Kuril and S. Kamchatka		13,800		unknown	1997	skiff and aerial	not corrected	--	complete	Kornev, KamchatRybVod
Russia - Kamchatka (except southern Kamchatka)		400	increasing	unknown	1997	skiff and aerial	not corrected	--	complete	Boiko and Ivanov, KamchatRybVod
Russia - Commander Islands										
Bering Island		3,316	stable	unknown	1995	skiff surveys	not corrected	--	complete	Burdin, KIEP; Zimenko, KamchatNIRO
Medney Island		1,300	stable	unknown	1997	skiff surveys	not corrected	--	complete	Burdin, KIEP; Zimenko, KamchatNIRO
USA - Aleutian Islands, Alaska	19,156		decline	-7 to -13% per year (1992 to 1997)	1992	aerial for abundance / skiff for decline	corrected	yes	--	Evans *et al.* 1997; Tinker and Estes, USGS, personal comm.
USA - Alaska Peninsula, Alaska	39,771		unknown	unknown	1986 1989	aerial survey	corrected	yes	--	Brueggeman *et al.* 1987; DeGange *et al.* 1994

POPULATION	ESTIMATE	ACTUAL COUNT	STATUS	RATE OF CHANGE	YEAR	SURVEY METHODS	CORRECTED FOR UNSEEN ANIMALS?	FOR ESTIMATES: CONFIDENCE INTERVAL AVAILABLE?	FOR ACTUAL COUNTS: PARTIAL OR COMPLETE COUNT?	SOURCE
USA - Kodiak Archipelago, Alaska	9,738		unknown	unknown	1994	aerial survey	corrected	yes	--	USFWS unpublished data
USA - Cook Inlet, Kenai Coast and Prince William Sound, Alaska	22,867		stable	unknown	1989 1994 1994	aerial survey aerial survey skiff survey	corrected corrected not corrected	yes yes yes	-- -- --	DeGange *et al.* 1990; Bodkin, USGS, pers comm; Agler *et al.* 1995b
USA - Southeast Alaska	8,807		increasing	up to 20% per year	1994 1995	skiff survey, aerial survey	not corrected corrected	yes yes	-- --	Agler *et al.* 1995a; Doroff and Gorbics, 1997
Canada - British Columbia		2,200	increasing	up to 18% per year	1997	skiff survey	not corrected	--	complete	J. Watson, Malaspina University, pers. comm.
USA - Washington		502	increasing	up to 18% per year	1997	aerial survey	not corrected	--	complete	Jameson, USGS, pers. comm.
USA - California		2,200	stable or decreasing (1995-1997)	-2% per year	1997	shoreline survey and aerial survey	not corrected	--	complete	Hatfield, USGS, pers. comm.
Mexico - Baja California		9	unknown	unknown	1991	interviews	not corrected	--	partial	Gallo-Reynoso andRathbun 1997
TOTAL	102,989	23,788								
GRAND TOTAL (estimate)	more than 126,777									

TABLE 2 - ISSUES OF CONCERN BY REGION AND RECOMMENDED ACTIONS, 1997

POPULATION	MONITORING NEEDS	THREATS TO POPULATION	CONSERVATION ACTIONS	RESEARCH NEEDS
Japan - Cape Nossapu	continue periodic surveys			sources of otters, activity, potential conflicts with commercial activity
Russia - Kuril Islands		poaching	regulations and enforcement	determine movement patterns, population structure, and population status
Russia - Kamchatka (except southern Kamchatka)	continue periodic surveys	contamination, oil, shipping, military, fisheries conflicts	regulations and fisheries closures	determine movement patterns, ecosystem studies, evaluate unoccupied habitat
Russia - Commander Islands	continue periodic surveys	poaching	regulations and enforcement	determine movement patterns and population status
USA - Aleutian Islands, Alaska	continue periodic surveys, determine cause and extent of decline, benthic prey surveys	predation, contamination, ecological shift in Bering Sea	contaminant clean-up	determine cause of decline, extent of decline, and community response to population decline
USA - Alaska Peninsula, Kodiak, Alaska	continue periodic survey, determine population trend	oil transport, harvest, contamination	encourage sustainable harvest	determine population status, monitor population expansion
USA - Cook Inlet, Kenai Coast and Prince William Sound, Alaska	continue periodic survey, determine population trend	oil transport, harvest, contamination	encourage sustainable harvest	determine population status, monitor recovery from *Exxon Valdez* oil spill
USA - Southeast Alaska	continue periodic survey, determine population trend	fisheries conflicts, harvest	encourage sustainable harvest	monitor rate of change and population expansion, evaluate effects of sea otters on soft bottom communities, evaluate fisheries conflicts and develop mitigative strategies
Canada - British Columbia	continue periodic survey	contamination, fisheries conflicts, poaching		continuing ecosystem monitoring
USA - Washington	continue periodic survey	oil transport, poaching, potential harvest by Natives		
USA - California	continue periodic survey	oil transport, fisheries conflicts, poaching, contaminants		determine cause of reduced growth, evaluate disease in wild population, evaluate contaminants in environment
Mexico - Baja California		oil transport, fisheries conflicts		

Appendix B

Participating Organizations
Sixth US - Russia Joint Sea Otter Workshop
November 1997

US Organizations

Alaska Biological Science Center
Alaska Department of Fish and Game
Alaska Sea Otter Commission
California Department of Fish and Game
Friends of the Sea Otter
Monterey Bay Aquarium
Smithsonian Institution
University of Washington
University of California
University of Alaska
US Geology Survey - Biological Resources Division
US Fish and Wildlife Service

Russian Organizations

Commander Islands Biology Station
Kamchatka Research Institute of Fisheries and Oceanography
Kamchatka Department of Environment
Kamchatka Institute of Ecology
Marine Mammals Laboratory
Pacific Research Institute for Fisheries and Oceanography
Russian Academy of Sciences

Japanese Organizations

University of Hokkaido

Appendix C

List of Presenters and Abstracts

Ames, J. A., Geibel, J. J., Wendell, F. E., and Pattison, C. A.
White shark-inflicted wounds of sea otters in California, USA, 1968-1992

Ames, J. A., Staedler, M. M., Hatfield, B., Geibel, J. J., Harris, M. H., Espinosa, L., Imai, R., and Muskat, J.
Dead sea otter drift study, a follow-up

Ballachey, B. E., Snyder, P. W., Bodkin, J. L., Monson, D. H., and Rebar, A. H.
Bioindicators of oil exposure in sea otters

Bodkin, J. L., Kelly, B. P., and Esslinger, G. E.
Monitoring sea otter dives with ultra-sonic transmitters and time-depth recorders

Burdin, A. M.
Status of sea otter populations in Russia

Carter, S. K., and VanBlaricom, G. R.
Effects of sea otter predation and commercial red urchin *(Strongylocentrotus franciscanus)* harvest on nearshore ecosystems in northern Washington, USA

Casson, C. J.
Raising a rehabilitated sea otter pup in Washington's Seattle Aquarium, USA

Fukuyama, A., and VanBlaricom, G. R.
Sea otter foraging in Prince William Sound, Alaska, USA: A benthic perspective

Gage, T., and VanBlaricom, G. R.
Competition between sea otters and predatory benthic invertebrates for bivalve prey in Prince William Sound, Alaska, USA: Implications for recovery of sea otters from the *Exxon Valdez* oil spill

Gorbics, C. S.
Summary of sea otter (*Enhydra lutris kenyoni*) survey results in Alaska, USA

Gorbics, C. S., and Bodkin, J. L.
Stock identity of sea otters (*Enhydra lutris kenyoni*) in Alaska, USA

Hanni, K., Staedler, M. M., Gulland, F., Estes, J. A., Williams, T. D., and Mazet, J.
Tools for management: Assessment of the health of the southern sea otter (*Enhydra lutris nereis*) population and the health, survival and behavior of rehabilitated and free-ranging pups

Hatfield, B., and Jameson, R. J.
Status of the California (USA) sea otter population as indicated by recent surveys and mortality patterns

Hattori, K.
Sea otters on the East Coast of Hokkaido, Japan

Jameson, R. J., Jeffries, S., and Kenyon, K. W.
Status and trends of the Washington, USA, translocated sea otter population

Jeffries, M.
Incorporating training into a husbandry program for the southern sea otter, *Enhydra lutris nereis*, at the Monterey Bay Aquarium, California, USA

Kawabe, Y.
Weight changes of sea otters in gestation period and estimating delivery day, Osaka Aquarium, Osaka, Japan

Kornev, S. I.
Results of sea otter surveys on Southern Kamchatka *[п-ов Камчатка]* and Northern Kuril Islands *[Курильские о-ва]*, Russia, in June 1997

Results of long term monitoring of sea otters in Southern Kamchatka (Cape Lopatka - *м. Лопатка*), Russia

Larson, S., and Wasser, S.
Monitoring reproductive health in sea otters

Maminov, M. K.
Status of the sea otter population on the Kuril Islands *[Курильские о-ва]*, Russia

Monson, D. H., Bodkin, J. L., and Ballachey, B. E.
Recovery of sea otters following the *Exxon Valdez* oil spill, Alaska, USA: An ecosystem approach

Nikulin, V. S.
Results of sea otter tagging on Kamchatka Peninsula *[п-ов Камчатка]* and Commander *[Командорские о-ва]* and Kuril Islands *[Курильские о-ва]*, Russia, in 1996 and 1997, and future perspectives

Ramirez, K., Hudson, M., and Takaki, L.
Initiation of a sea otter training program

Shevchenko, I. N.
Daily activity time budget and prey composition of sea otters on Medny Island *[о. Медный]*, Russia

Staedler, M. M., Hymer, J. A., and Williams, T. D., DVM
Monterey Bay (USA) Aquarium's sea otter research and conservation program history, statistics, and release outcomes: January 1984 - September 1997

Styers, J., Jones, M. H., DVM
International transport of sea otters

Thomas, N. J.
An update on the causes of mortality in southern sea otters

Tinker, T., and Estes, J. A.
Sea otter population decline in Alaska's Western Aleutian Islands, USA: An overview of trends, effects, and possible causes

VanBlaricom, G. R.
Food consumption rates by captive wild sea otters

VanBlaricom, G. R., Burdin, A. M., Gerber, L. R., and Rubin, R. D.
Estimation of pre-exploitation sea otter population sizes in the Northwest Pacific Ocean using archival harvest data and modern population growth data

Vertenkin, V. V.
Sea otters of Ytashud Island *[о. Уташуд]*, Kamchatka Peninsula *[п-ов Камчатка]*, Russia

Watson, J., Ellis, G., and Ford, K. B.
Population growth and expansion in Canada's British Columbia sea otter population

Watson, J., and Estes, J. A.
Changes in community structure associated with sea otter foraging in shallow rocky areas off northwestern Vancouver Island, Canada

Zasypkin, M. Yu.
Allozyme variability in sea otters *(Enhydra lutris lutris):* Investigation of biochemistry genetics methods

Zimenko, N. P.
Foraging strategies of sea otters on Medny Island *[о. Медный]*, Russia

WHITE SHARK-INFLICTED WOUNDS OF SEA OTTERS IN CALIFORNIA, USA, 1968-1992

Ames, J. A. (1), Geibel, J. J. (2), Wendell, F. E. (3), and Pattison, C. A. (3)

(1) California Department of Fish and Game, Monterey, CA, USA

(2) California Department of Fish and Game, Menlo Park, CA, USA

(3) California Department of Fish and Game, Morro Bay, CA, USA

Lethal wounds on sea otters *(Enhydra lutris)* caused by white sharks *(Carcharodon carcharias)* in California have been confirmed by (1) shark tooth enamel fragments remaining in sea otter's wounds, (2) scratch patterns on sea otter bone or cartilage that match the serrate edge of white shark teeth, and (3) multiple cuts on various aspects of sea otter carcasses, some of which may be "stab-like" in appearance. Conclusive evidence that white sharks eat sea otters is not available. It is possible that they merely bite and release sea otters, often killing them in the process.

Approximately 8% (163 of 2013) of California sea otter carcasses inspected from 1968 to 1992 exhibited very strong evidence of having been wounded by white sharks; including all dead otters with cuts (N= 219), the prevalence reaches 11%. Lethally bitten otters occurred in all months of the year and throughout most of the sea otter's California range, but seasonal and spatial concentrations were also apparent. The number of shark-bitten sea otter carcasses recovered annually, rangewide, varied little during the study period, despite a doubling of the sea otter population.

We estimate that the annual sea otter mortality caused by white sharks averaged 0.5% throughout the California range of the sea otter. In the vicinity of Año Nuevo Island, however, white shark-caused mortality reached 20% (averaging 8%) of that sub-population in some years.

Dead Sea Otter Drift Study, a Follow-Up

Ames, J. A. (1), Staedler, M. M. (2), Hatfield, B. (3), Geibel, J. J. (4), Harris, M. H. (5), Espinosa, L. (6), Imai, R. (7), and Muskat, J. (7)

(1) Oiled Wildlife Veterinary Care and Research Center, 1451 Shaffer Road, Santa Cruz, CA 95060, USA

(2) Monterey Bay Aquarium, 886 Cannery Row, Monterey, CA 93940, USA

(3) US Geological Survey - Biological Resource Division, California Science Center, Piedras Blancas Field Station, San Simeon, CA, USA

(4) California Department of Fish and Game, Menlo Park, CA, USA

(5) California Department of Fish and Game, Morro Bay, CA, USA

(6) California Department of Fish and Game, Monterey, CA, USA

(7) California Department of Fish and Game, Sacramento, CA, USA

Determining the rate at which dead sea otters strand following death from oil contamination will be important to the damage assessment process. Using techniques and materials similar to those used by Doroff and DeGange (1995), we constructed dead sea otters dummies from half car tires. To determine if the dummies drifted and beached in a similar way to real sea otters carcasses, we released carcasses and dummies at a ratio of one to one in 15 batches totaling 66 drift targets over two years. All drift targets were released very near the same location off the end of the Monterey Peninsula, California, USA (approximately .8 km off Point Joe, 36.617° N lat. and 121.967° W long.).

Results show that carcasses and dummies have highly variable drift patterns, but do not drift differently from one another. We believe a stockpile of such dummies would be useful in determining stranding rates following an oil spill. Winds at the release site of approximately 10 knots or greater in an onshore direction nearly always resulted in target stranding near the release site within 24 hours. Light winds and offshore winds at the time of release resulted in much wider dispersion and sometimes loss at sea.

We also monitored two tethered floating sea otter carcasses to disintegration and predict that most freshly dead sea otter carcasses would float for approximately 40 days, depending on water temperature and sea state, before losing buoyancy and sinking.

BIOINDICATORS OF OIL EXPOSURE IN SEA OTTERS

Ballachey, B. E. (1), Snyder, P. W. (2), Bodkin, J. L. (1), Monson, D. H. (1), and Rebar, A. H. (2)

(1) Alaska Biological Science Center, US Geological Survey - Biological Resources Division, 1011 East Tudor Road, Anchorage, AK 99503, USA

(2) School of Veterinary Medicine, Purdue University, West Lafayette, IN 47907, USA

A major component of the ongoing Nearshore Vertebrate Predator (NVP)[1] study addresses the issues of continued exposure of sea otters in Prince William Sound, Alaska, USA, to residual oil from the 1989 *Exxon Valdez* oil spill and, if exposure continues, possible adverse effects on health of the otters. To evaluate exposure, we are measuring expression of cytochrome P450 1A1, an enzyme induced by aromatic hydrocarbons and PCBs, with two approaches: (1) a PCR assay, using blood lymphocytes, and (2) an immunohistochemical assay (conducted by Dr. J. Stegeman at Woods Hole Oceanographic Institute), using skin samples from flipper and underarm. To evaluate health of individual otters, we are measuring weight/length ratios as an index of body condition, and collecting blood samples for hematology, serum chemistry, and serum protein electrophoresis.

Preliminary results from otters captured in 1996, based on the PCR assay of lymphocytes, showed higher expression of P450 1A1 in sea otters from oiled areas, indicating exposure to contaminants. We cannot conclusively state, however, that the source of the contamination is oil from the 1989 spill, versus other hydrocarbon or PCB contaminants in the environment. Analyses of skin for P450 1A1 were inconclusive due to problems with handling of samples collected in 1996.

Body condition, when comparing otters of similar age and sex, did not differ between oiled and unoiled areas in 1996. In general, hematology, serum chemistry and protein electrophoresis results from 1996 showed few differences between otters in oiled and unoiled areas; however, several serum enzymes indicative of liver dysfunction were slightly elevated in otters from the oiled area.

Additional samples were collected in summer 1997, and analyses are underway. Our preliminary conclusion is that exposure to residual oil may be continuing, but based on our measures of individual health, we have not detected adverse effects on the sea otters associated with this exposure.

[1] *See accompanying abstract by D. Monson et al.,* "Recovery of Sea Otters following the Exxon Valdez Oil Spill: An Ecosystem Approach"

MONITORING SEA OTTER DIVES WITH ULTRA-SONIC TRANSMITTERS AND TIME-DEPTH RECORDERS

Bodkin, J. L. (1), Kelly, B. P. (2), and Esslinger, G. E. (1)

(1) Alaska Biological Science Center, US Geological Survey - Biological Resources Division, 1011 East Tudor Road, Anchorage, AK 99503, USA

(2) University of Alaska, Juneau Center, Fisheries Division, 11120 Glacier Highway, Juneau, AK 99801, USA

In 1996, we deployed 6 pressure-modulated ultrasonic transmitters on male sea otters in Southeast Alaska, USA. In 1997, we deployed 12 identical transmitters (50-78 kHz) on 10 female and 2 male sea otters and 12 time depth recorders, also on 10 females and 2 males in Southeast Alaska.

Sonic transmitters and time-depth recorders were secured to a rear flipper with absorbable suture material passed through the flipper and a Teflon button placed on the opposing side of the flipper. External VHF radio transmitters attached to the other rear flipper allowed us to locate sea otters with flippers out of the water. Ultrasonic transmitters provided a signal at one-second intervals for about 14 days while time-depth recorders stored depth data at two-second intervals for about 46 days. Ultrasonic signals were received at distances up to 1,200 m from stationary and mobile tracking stations.

We received signals suitable for estimating dive parameters from 15 of the 18 sonic transmitters and recovered 2 of the 12 time-depth recorders. Maximal dive depths of 86 meters were indicated by both types of instruments. Both instruments provided similar data on dive parameters such as duration, depth, ascent, and descent rates. Time-depth recorders store continuous data and may be useful in estimating time-activity budgets, but the instruments can be difficult to recover.

Status of Sea Otter Populations in Russia

Burdin, A. M.
Laboratory of Animal Ecology, Kamchatka Institute of Ecology, Russian Academy of Sciences, Prospect Rybakov 19a, Petropavlovsk-Kamchatsky, 683024, Russia

Sea otters are not identified as endangered in Russia, but they are listed in the Russian Red Book as a Category 5 population: one that has not recovered to previous levels. Sea otters in Russia were hunted for more than 150 years without regulation until, by 1900, only small isolated populations remained. The International Fur Seal Treaty of 1911 protected the sea otter, allowing its ongoing recovery.

Sea otters have reoccupied pockets of habitat in the Commander Islands *[Командорские о-ва]*, Kamchatka Peninsula *[п-ов Камчатка]*, and Kuril Islands *[Курильские о-ва]* to Japan. Two major population groups have been identified: Commander Island and southern Kamchatka / northern Kurils. Additional study is needed to map current distribution throughout the Kuril Islands. Where sea otters have been established for some time, populations are at carrying capacity. Even there, however, threats to their habitat arise due to human occupation and potential environmental disasters.

Research is needed on the following topics: length of occupation, degree of isolation, probability of increased dispersal, level of genetic polymorphism, and habitat requirements. Because of the "island" nature of the habitat occupied by sea otters in this region, dispersion may be limited.

Commander Islands: Historical dispersion has been described since the 1970s when movements from Medny *[о.Медный]* to Bering Island *[о. Беринга]* were first observed. Counts on Medny Island peaked in the mid-1970s at 2,000. By the 1980s, however, numbers dropped sharply on Medny Island, concurrent with a rise in numbers on Bering Island. Overall productivity was believed to remain constant. Counts on Medny Island have subsequently stabilized. Population growth rates have been documented as high as 17.5%, with mortality rates stabilizing at 9.5% or less by the end of the 1980s.

In 1991, about 700 dead sea otters were found on Bering Island, predominantly adult males. (Records indicate that 1985 was also a high mortality year.) Historic counts from the Commander Islands, 1919 to 1993, are summarized in the following Table A. By 1997, it is believed that the population throughout the Commander Islands is at equilibrium density and is stable at approximately 5,000 to 5,500 sea otters.

Kamchatka Peninsula: Traditionally sea otters were abundant on the Kamchatka Peninsula. Kronotski Bay *[Кроноцкий з.]* was even nicknamed "Beaver Bay" after the large resident population of sea otters. The population survived at Cape Lopatka *[м. Лопатка]*, the southern-most cape of the peninsula, despite heavy hunting prior to 1900. Currently, the northern end of their range is Cape Kamchatka *[м. Камчатский]* (summer range may extend to Karaginski Island *[о. Карагинский]*). The southern Kamchatka to Cape Lopatka population has persisted the longest and numbers are probably continuing to grow. It is believed that this region may support 2,500 to 3,000 animals overall. The number may be variable, however, due to movement between southern Kamchatka Peninsula and northern Kuril Islands. Counts from the Kamchatka Peninsula's Cape Kronotski *[м. Кроноцкий]* are summarized in the following Table B.

TABLE A.

Sea Otters in Russia's Commander Islands *[Командорские о-ва]*		
Year	Adults	Pups
1919	1,200	270
1930	1,070	290
1932	815	148
1981	1,046	141
1983	789	150
1984	704	200
1985	1,144	327
1993	1,283	U

TABLE B.

Sea Otters in Russia's Kamchatka Peninsula Cape Kronotski *[м. Кроноцкий]* (pups included)	
Year	Adults & Pups
1980s	70-80
1991	1,000
1994	741
1996	300-350
1997	>90

Kuril Islands: There are possibly two or three isolated subgroups in this area. Interchange is possible, although the extent and opportunity are not understood. The central Kuril subgroup has skull morphology more similar to the Commander Islands than to other Kuril Island subgroups. The population status in this region is uncertain. [1,2]

All the regions share the following threats: poaching, contamination of habitat, and fisheries conflicts. Poaching is of grave concern because it is believed that a black market exists within Russia to illegally export pelts to China, Korea and Japan.

[1] *see also tables in accompanying abstract by Kornev* "Results of Sea Otter Surveys on Southern Kamchatka and Northern Kuril Islands, Russia"

[2] *see also accompanying abstract by Maminov* "Status of the Sea Otter Population on the Kuril Islands, Russia"

Effects of Sea Otter Predation and Commercial Red Urchin (*Strongylocentrotus franciscanus*) Harvest on Nearshore Ecosystems in Northern Washington, USA

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Sea otter predation and commercial urchin harvest are ecologically and economically important disturbances to nearshore ecosystems in northern Washington, USA. This project uses experimental manipulation of red urchin densities to examine effects of these disturbances on nearshore ecosystems in the San Juan Islands. Our two main objectives are 1) to determine if changes observed in outer coastal habitats of the North Pacific subject to sea otter predation also occur in the physically protected inland waters of Puget Sound, and 2) to examine potential differences in effects of sea otters and commercial urchin fishermen on nearshore species.

Nine sites were established in nearshore rocky bottom areas of San Juan Channel in Fall 1996. Experimental treatments are applied to six sites, three for each of the following: 1) monthly removal of all red urchins to simulate continuous sea otter predation, and 2) annual removal of legal-sized red urchins (102-140 mm test diameter) to simulate commercial harvest. Three sites are control sites where urchin densities are not altered. Density and species composition of kelps, large invertebrates, and nearshore fish are monitored as indicators of community change, along with size frequency distribution of red urchins. These response variables are sampled pre-harvest and 5, 40, 90, 180, and 270 days post-harvest.

Approximately 3,000 urchins were harvested from the six treatment sites in March 1997. Red urchins were the most abundant species pre-harvest, followed by various species of cucumbers, crabs, stars, and other invertebrates. Fishery and sea otter treatments reduced urchin densities by approximately 55% and 98%, respectively. Monthly immigration of urchins into sea otter treatment sites repopulates the sites from 1% to 14% of pre-harvest densities. Urchin densities in commercial urchin harvest sites had increased to an average of 51% of pre-harvest densities by 180 days post-harvest.

Preliminary data on kelp and invertebrate population pre- and post-harvest will be presented Implications for urchin management strategies in this region will be discussed, along with potential impacts of a range expansion of sea otters into inland Washington waters.

Raising a Rehabilitated Sea Otter Pup in Washington's Seattle Aquarium, USA

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In July of 1997, a female sea otter (*Enhydra lutris*) was orphaned when it's mother was struck and killed by a power boat. Injuries inflicted to the pup were treated by representatives from the U. S. Fish and Wildlife Service. When the animal's condition was stabilized, she was transported to The Seattle Aquarium, Washington, USA, for long term care.

This presentation will discuss the Seattle Aquarium's husbandry protocol and steps taken to introduce the pup into an exhibit containing three adults.

Sea Otter Foraging in Prince William Sound, Alaska, USA: A Benthic Perspective

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In Prince William Sound, Alaska, sea otters feed mainly on bivalves. Benthic feeding by sea otters provides an opportunity to examine feeding habits by collecting the dead shell feeding record. Sea otters and their primary prey were studied in two areas in Prince William Sound from 1995 to 1997. One area was oiled by the 1989 *Exxon Valdez* oil spill while the other area was not oiled.

We examined the feeding habits of sea otters by using transects to collect otter-fed shells. We also looked at the population ecology of bivalves in those areas. Larval settlement of bivalves was examined by using larval collection tubes, juvenile settlement was seen by collecting benthic cores, and adult clams were collected using a Venturi suction dredge.

Sea otters were more abundant in unoiled areas and thus more otter-fed shells were found in unoiled areas. Adult clams were also more abundant in unoiled areas. The primary bivalve fed upon by sea otters was the butter clam *(Saxidomus giganteus)*, but the primary clam found by dredging was *Macoma*. Juvenile clams were found in low numbers at both areas. The most abundant species of clams found in the cores were *Mysella tumida* and *Tellina modesta*.

Competition Between Sea Otters and Predatory Benthic Invertebrates for Bivalve Prey in Prince William Sound, Alaska, USA: Implications for Recovery of Sea Otters from the *Exxon Valdez* Oil Spill

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Sea otter (*Enhydra lutris)* numbers in some areas of Prince William Sound (PWS), Alaska, USA, have not yet recovered from the effects of the 1989 *Exxon Valdez* oil spill. One possible explanation is the spill-induced changes in sea otter prey populations. We studied effects of predatory benthic invertebrates (sea stars, snails, crabs) on the dynamics of clam populations, the primary prey of sea otters in Prince William Sound. We evaluated the hypothesis that high rates of clam consumption by predatory invertebrates are limiting the size of clam populations and consequently, the local recovery of sea otters from the oil spill.

We collected data on density and diet of predatory invertebrates at 4-10 m depth relative to MLLW (mean lower low water) in four study areas, two oiled by the spill and two unoiled, in December 1995 and June/July 1996. We found the sea star *Pycnopodia helianthoides* (Brandt) to be the most abundant predatory benthic invertebrate in our study areas. Densities of *Pycnopodia*, however, were not significantly different between oiled and unoiled study areas. Although published literature suggests broad overlap in diets of *Pycnopodia* and sea otters, our data indicate that *Pycnopodia* in Prince William Sound have a diverse diet composed primarily of gastropods too small to be of significant nutritional value to sea otters. Clams were present in the diet of *Pycnopodia*, but at very low numbers in all areas. Clam species and size categories typically consumed by sea otters in Prince William Sound were poorly represented in sampled *Pycnopodia* diets.

We conclude from our data that predatory invertebrates are not likely significant competitors with sea otters for prey in Prince William Sound. It follows that predatory invertebrates are not a significant trophic impediment to the recovery of the sea otter populations from the effects of the 1989 oil spill.

SUMMARY OF SEA OTTER (*ENHYDRA LUTRIS KENYONI*) SURVEY RESULTS IN ALASKA, USA

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Historically, sea otters occurred in nearshore waters around the North Pacific rim from Hokkaido, Japan, through the Kuril Islands, Kamchatka Peninsula, the Commander Islands, the Aleutian Islands, peninsular and south coastal Alaska, and southward to Baja California (Kenyon 1969). Although the numbers worldwide, including Alaska, were reduced to less than 1,000 to 2,000 by the early 1900s (Johnson 1982), it is estimated that 100,000 to 150,000 sea otters occur presently occur in Alaska (USFWS 1994).

A combination of aerial and boat surveys have been conducted in Alaska over the past three decades. This information is summarized by region:

The **Southeast Alaska region** extends from the southern boundary of Alaska north to Cape Yakataga which is north of Yakutat. The combined population estimate for the southeast region is 8,807 (± 6,292) based on surveys conducted between 1994 and 1995 (Agler *et al.* 1995a; Doroff and Gorbics 1997).

The **Southcentral Alaska region** extends from Cape Yakataga to the east coast of Cook Inlet and includes Prince William Sound, Kenai Peninsula coast, and Kachemak Bay. The combined population estimate for the southcentral region is 22,867 (± 5,686) based on surveys conducted between 1989 and 1995 (USGS/BRD unpublished data, Agler *et al.* 1995b, DeGange *et al.* 1994).

The **Southwest Alaska region** extends from the western shore of Cook Inlet south and west to the Alaska-Russia border and includes the Barren Islands, Kodiak Archipelago, Alaska Peninsula, Pribilof Islands, and Aleutian Islands. The combined population estimate for the southwest region is 68,212 (± 12,840) based on surveys conducted between 1986 and 1994 (Brueggeman *et al.* 1988, Evans *et al.* 1997, USFWS unpublished data, USGS/BRD unpublished data).

The statewide combined population estimate is 99,886 (±15,270). The observed trend in most areas with persisting subpopulations since 1911 has been one of growth, with declines usually observed only in localized areas where sea otters exceeded their available food resources (DeGange and Bodkin unpublished report). There is evidence, however, from recent work[1] on sea otters at Adak Island, in the central Aleutian archipelago, that the population has been undergoing a major decline. Causes of mortality to sea otters may include incidental take in fisheries, Alaska Native harvest, take for public display or research, oil spills, poaching, disease, predation, and food depletion.

[1] *see accompanying abstract by Tinker and Estes,* "Sea Otter Population Decline in Alaska's Western Aleutian Islands: An Overview"

ALLOZYME VARIABILITY IN SEA OTTERS *(ENHYDRA LUTRIS LUTRIS)*: INVESTIGATION OF BIOCHEMISTRY GENETICS METHODS

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After the historic exploitation of sea otters for furs, few individuals survived on Russia's Commander Islands *[Командорские о-ва]* that it was hypothesized that as the population recovered, it would be homzygous in its genetics. Using electrophoretic techniques to compare allozymes, the sea otters were found instead to be polymorphic, leading to the conclusion that the population grew from a few homozygous individuals, but each carried different alleles. When they interbred, they produced heterozygosity.

Sea otters that died during the big winterkill of 1990-91 (804 dead in a population of 1,500 to 4,000 otters) were examined to determine whether there was a bias toward homogeneity in the die off. Blood and tissue samples were taken from otters at one site on Medney Island *[о. Медный]*, two sites on Bering Island *[о. Беринга]*, and as a control, one site on Shumshu Island *[о. Шумшу]* in the Kurils *[Курильские острова]*. Comparing the dead animals with the rest of the population resulted in higher allozyme variability than seen before, perhaps because of advances in technology. All Bering Island samples had high heterogeneity. The conclusion is that the Commander Island sea otter population has a high genetic success rate.

For specific results, refer to two articles co-authored with A. M. Burdin in the *Russian Journal of Genetics* (translated), 1 September 1997, Vol 33, No 9: subtitled *"Description and genetic interpretation of markers* pages 1065+ and subtitled *"Genetic heterogeneity within the species"* pages 1072+.

FORAGING STRATEGIES OF SEA OTTERS ON MEDNY ISLAND *[о. Медный]*, RUSSIA

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In Russia's Commander Islands *[Командорские о-ва]* in July 1995, sites within Medney Island's *[о.Медный]* Glinka Bay *[б. Глинка]* were marked for monitoring sea otter diving, feeding, movement, and prey size and type. Telescopes were used for observations from boats and shore.

Results showed that the type of foraging can be characterized according to distribution of benthic prey assemblages. If a specific feeding spot is large, sea otters will remain on-site. This is described as "foraging on-site." If feeding area is smaller, sea otters will feed in multiple feeding areas during each feeding bout. This is described as "foraging underway." There is generally little repeat diving in same area when an otter is foraging underway. Mixed foraging bouts were also observed.

Sea urchins and sand lance were major prey items at Medny Islands. Females foraging on-site brought up urchins with average diameter of 4.36 cm. Females foraging underway brought up urchins with average diameter of 3.96 cm. (Maximum urchin size observed was 8 cm.) On average, 8 to 10 urchins were foraged per dive (maximum 38 per dive). Analysis of caloric content and caloric cost of average feeding bouts showed that females foraging on-site scored >1% higher kilocalories than those foraging underway.

A 50% decline in sea otter abundance on Medny Island was recorded in 1990-1991. The sea otter population has remained at low levels. Food supply has remained abundant, however, and feeding strategies have not changed. No explanation has been found for the Medny Island decline.

STATUS OF THE SEA OTTER POPULATION ON THE KURIL ISLANDS *[Курильские о-ва]*, RUSSIA

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After the International Fur Seal Treaty of 1913, sea otters were know to exist on five island groups in the Kurils *[Курильские о-ва]* with less than 10 individuals in each remnant group: Shumshu *[Шумшу]*, Paramushir *[Парамушир]*, mid-Kurils, Urup *[Уруп]*, and Iturup *[Итуруп]*. Historically and currently the southern Kurils have not supported many sea otters. Early fur hunters exploring the Kuril Islands did not note sea otters occurring south of Iturup Island. Harvest of a thousand animals from that region must have been enabled by a migration of central Kuril sea otters fleeing hunters.

Some survey data is available between 1955 and 1991. Sea otters inhabited all major islands by 1963 and a time of population growth began that stabilized by 1990. On Iturup Island in the southern Kurils, less than 10 were observed in the 1950s. By 1963 about 100 were found in the north and 17 in the south. In 1988-89, there was a sharp increase in numbers on the southern end of Iturup Island concurrent with a sharp decrease on the northeast end, which was often blocked by ice. A shift in the concentration, and not a change in abundance, likely was the result. Movement between the two areas continued throughout the 1990s. In 1997, unusually heavy ice conditions persisted into March and April and reduced numbers again. It is believed that such periodic ice conditions constrain sea otter growth along the Sea of Okhotsk *[Охотское Море]* side of the Kuril Islands.

In the central Kurils, a catastrophic decline between 1995 and 1997 on Simushir *[Симушир]* Island (400 to 60 animals) could be due to poaching. There is no law enforcement in this area.

Studies have included food supply, diet, tooth wear, and skull size. A majority of prey taken shifted from urchins in the 1970s to bivalve mollusks in the 1980s. An increase in skulls found with damaged teeth may indicate the increasing presence of sand or dirt in the prey. Phenotypic changes have been observed in the sea otter populations, possibly due to population status. Skull size and body size decrease with increasing population densities in these areas.

Recovery of Sea Otters Following the *Exxon Valdez* Oil Spill, Alaska, USA: An Ecosystem Approach

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Nearshore marine communities were altered through direct mortality and potentially through modified community structure and function following the 1989 *Exxon Valdez* oil spill in Prince William Sound, Alaska, USA. Evaluation of change effected by the spill will likely remain uncertain because of inadequate pre-treatment data. Evidence exists, however, that effects on community structure and species abundance persisted beyond the immediate event. Given demographic constraints and potential chronic effects of the spill, the question becomes: "What is the status of community recovery?"

To determine the current recovery status of the nearshore ecosystem, a four-year project entitled "The Nearshore Vertebrate Predator (NVP)" study was initiated in 1995. The NVP study assesses the status of four top predator species (sea otter, river otter, harlequin duck, and pigeon guillemot) to evaluate the health of the nearshore coastal ecosystem. For all four species, demographic parameters, trophic interactions, measures of individual health, and bioindicators of oil exposure are being collected in a heavily oiled area and in a nearby unoiled area. For sea otters, information is being collected on abundance, reproduction, survival, body condition, hematology and serum chemistry, immune response, cytochrome P450 levels, foraging success and prey populations.

Preliminary results found significantly higher expression of the enzyme P450 1A1 in sea otters from the spill area. Reproductive rates of sea otters in the oiled and unoiled areas are similar. The abundance of sea otters in some oiled areas remains low and below pre-spill estimates. Colonization of the oiled area in 1996 by a group of male sea otters is suggestive of the initial stages of population recovery.

Prey composition between areas is similar, but sea otters in the oiled area recover larger prey items. Larger and more abundant invertebrate prey populations where sea otters were reduced indicate a response to reduced sea otter predation. In conclusion, initial results of the NVP study suggest that sea otters and the nearshore coastal ecosystem affected by the 1989 oil spill have not yet fully recovered.

STOCK IDENTITY OF SEA OTTERS (*ENHYDRA LUTRIS KENYONI*) IN ALASKA, USA

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Sea otters in Alaska are recognized as a single subspecies (*Enhydra lutris kenyoni*) and managed as a single, interbreeding population. This paper applies the phylogeographic method (Dizon *et al.* 1992) and considers distribution, population response, and phenotype and genotype data to identify stocks of sea otters within Alaska.

The evidence for separate stock identity is genotypic (all stocks), phenotypic (Southcentral and Southwest stocks) and geographic distribution (Southeast stocks) while population response data were equivocal (all stocks). Genotype frequencies and the presence of unique genotypes among geographic areas shows sufficient variation to indicate restricted gene flow. Genetic exchange may be limited by little or no movement across proposed stock boundaries and discontinuities in distribution at proposed stock boundaries. Skull size differences (phenotypic) between Southwest and Southcentral Alaska populations further support stock separation. Population response information was equivocal in either supporting or refuting stock identity.

On the basis of this review, we suggest the following: (1) Southeast stock extending from Dixon Entrance to Cape Yakataga; (2) Southcentral stock extending from Cape Yakataga to Cape Douglas including Prince William Sound and Kenai peninsula coast; and (3) Southwest stock including Alaska Peninsula coast, the Aleutians to Attu Island, Barren, Kodiak, Pribilof Islands and Bristol Bay.

TOOLS FOR MANAGEMENT: ASSESSMENT OF THE HEALTH OF THE SOUTHERN SEA OTTER (*ENHYDRA LUTRIS NEREIS*) POPULATION AND THE HEALTH, SURVIVAL AND BEHAVIOR OF REHABILITATED AND FREE-RANGING PUPS

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Oil spill contingency plans for at-risk species require a thorough understanding of the benefits and risks of rehabilitation programs, in order to determine an appropriate response for treating oiled wildlife. Important to this effort is knowledge about baseline health, behavior, and survival parameters to compare to rehabilitated individuals. Due to its limited range, the southern sea otter (*Enhydra lutris nereis*) is a threatened population at risk of extinction from catastrophic events such as oil spills or disease epidemics.

This study, begun in 1997 and continuing through 2001, will determine 1) seroprevalence of antibodies to several terrestrial and marine mammal pathogens of concern in free-ranging sea otters; and 2) the behavior, survival, and health of rehabilitated and released-to-the-wild southern sea otter pups and compare them to those of free-ranging pups.

Preliminary analyses of banked sera from rehabilitated (n=3) and free-ranging southern (n=8) and Alaskan (*Enhydra lutris kenyoni*; n=7) sea otters were conducted to collect baseline health parameter data, including standard serum chemistry and whole blood parameters, and exposure to *Coccidioides immitis*, leptospira, calicivirus, and morbillivirus. None of the sera tested positive for exposure to these pathogens. Analysis of larger sample sizes for each group, including comparisons by sex and age classes, will be conducted. Preliminary results from the continuation of the seroprevalence study will be presented.

Rehabilitated southern sea otter pups released back to the wild are monitored to assess their survival, movements, and behavior. A control group of free-ranging recently weaned pups will be radio tagged and monitored. The survival, movements, behavior, and health parameters will be compared between the free-ranging and rehabilitated radio-telemetried pups. The results will be used to establish a cost-benefit analysis of rehabilitation methods.

MONITORING REPRODUCTIVE HEALTH IN SEA OTTERS

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Sea otters (*Enhydra lutris*) once ranged uninterrupted along coastlines bordering the North Pacific Ocean from the southern tip of Baja California to the islands of Japan, but were extirpated over much of their range by exploitation associated with the fur trade from the late 1700s to the twentieth century. By the early 1900s, only a few isolated and small sea otter populations remained. Today's sea otter range includes scattered stable remnant populations at carrying capacity (equilibrium), remnant populations below carrying capacity, and translocated populations below carrying capacity. Some populations below equilibrium have very low growth rates and are considered to be in danger of extinction if the growth rate doesn't increase.

The effects of small isolated sea otter populations on genetic variability and reproductive failure has been difficult to quantify because little is known about sea otter reproductive physiology and intrapopulation generic variation. Nothing is known about the complex endocrine interactions controlling estrus, luteal phase dynomers including pseudopregnancy, delayed implantation, and pregnancy.

In an effort to improve captive sea otter reproduction, The Seattle Aquarium and The Center for Wildlife Conservation have validated techniques to measure reproductive steroid hormones in female sea otters from feces and blood. The ability to measure endocrine levels across seasons is essential to determine the optimal times for mating, reproductive status, fertility of captive animals, and the physiological dynamics that underlay ovulation, implantation, pseudopregnancy, and pregnancy. The Seattle Aquarium is also developing a sea otter genetic library with highly variable nuclear genome microsatellites to determine intrapopulation generic variation and parental lineages in small and large wild and captive sea otter populations.

RESULTS OF LONG TERM MONITORING OF SEA OTTERS IN SOUTHERN KAMCHATKA (CAPE LOPATKA - *м. Лопатка*), RUSSIA

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A study was conducted between 1984 and 1993 on the biology of the sea otter population in the Cape Lopatka *[м. Лопатка]* region of Russia's southern Kamchatka Peninsula *[п-ов Камчатка]*. The minimum, average, and maximum numbers of animals were analyzed on a monthly and annual basis. Variations in maximum abundance ranged from 1,800 in 1984 to 550 in 1989 and 2,500 in 1993. From 1984 to 1993, 1,710 carcasses were found at Cape Lopatka. All were examined and 306 had morphological data recorded.

At least 11 causes of death were recorded at Cape Lopatka: disease, injury, trauma from surf action, unknown (59%), bear kills (14.6%), other predators (Orca whales *[Orcinus orca]*, minimal), oil pollution, shooting, dog attacks, food decline, and natural weather factors.

Although many researchers believe that food limitation may be a major cause of mortality, scat surveys on Cape Lopatka do not indicate this. Analysis of scat samples for 5 years show a stable diet pattern. Starving and emaciated animals are seen on Cape Lopatka in large numbers; however, this is correlated with bad weather conditions and storm activity that restrict the movements of animals into feeding areas.

In this area, brown bears share beach habitat with sea otters. As a result, the bears also serve as substantial regulators of sea otter abundance, especially in years when the bear's other prey is low.

STATUS OF THE CALIFORNIA (USA) SEA OTTER POPULATION AS INDICATED BY RECENT SURVEYS AND MORTALITY PATTERNS

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From 1983 to 1994 spring counts of the California sea otter population increased at from about 5% to 6% per year. Since 1994, the average growth rate has been -2% per year. These surveys, in addition to the lack of range expansion and recent increased mortality (as indicated by the number of beach-cast carcasses), provide compelling evidence that population growth has ceased.

SEA OTTERS ON THE EAST COAST OF HOKKAIDO, JAPAN

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Until recently, there have been few reports of sea otters (*Enhydra lutris*) on the east coast of Hokkaido, Japan. In February 1996, there were several newspaper and TV reports of sea otters in this area.

To learn more about these sea otters, we interviewed several people who have seen them, and conducted our own observations. They reported that one or two sea otters have bee seen intermittently since 1980. In both 1996 and 1997, we often observed one sea otter at Cape Nosappu. Both were male, 3-5 years old, based on their head color, and were seen catching birds. During our observation, the sea otters ate many sea urchins.

In this area, there are numerous fisheries, including the collection of seaweeds and sea urchins. If the sea otter population increases in the future, we must think about conflicts that might arise between the sea otters and the fisheries and about some other problems.

Status and Trends of the Washington, USA, Translocated Sea Otter Population

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During the late 1960s and early 1970s, more than 700 sea otters (*Enhydra lutris kenyoni*) were translocated from Alaska to areas where they had been extirpated during the fur trade era. The outer coast of Washington's Olympic Peninsula, USA, was one such site. In 1969, 29 sea otters from Amchitka Island, Alaska, were released near Pt. Grenville, Washington. The translocated otters were liberated directly to the open ocean from their transport cages and 16 (55%) were recovered dead within 2 weeks of the release. In 1970 another 30 sea otters were captured at Amchitka and translocated to Washington; this time they were released to holding pens located near La Push. After a period of acclimation they were liberated directly from the holding pens. No follow-up surveys were initiated until 1977, when 19 sea otters were counted.

Surveys were conducted biennially until 1989 and annually thereafter. In 1997, 502 sea otters were counted between Destruction Island and Neah Bay. Since 1989, when the current survey method was initiated, this population has increased at a finite rate of 11.4% per year ($R^2 = 0.969$). Most range expansion has occurred in the northern portion of the range; no established groups of sea otters have been noted south of Destruction Island. Extralimital sightings have been made in the San Juan Islands and near Olympia, at the extreme southern end of Puget Sound.

Morphological measurements suggest the population is still below "K" (the largest sea otter ever recorded in United States waters was captured in 1997 and weighed 46.2 kg and measured 149 cm TL).

Recent expansion of the range to east of Cape Flattery has brought the population into conflict with human fishers. At this point primarily with the sea urchin fishery. A resolution to the conflict has yet to be found.

The sea otter story in Washington State is one of success, in spite of poor planning in 1969 and two oil spills. Intervention by conservation agencies in this case has restored an extirpated species to a portion of its former range many decades before it would have returned naturally. USGS's Biological Resources Division plans to continue monitoring this population.

INCORPORATING TRAINING INTO A HUSBANDRY PROGRAM FOR THE SOUTHERN SEA OTTER, *ENHYDRA LUTRIS NEREIS*, AT THE MONTEREY BAY AQUARIUM, CALIFORNIA, USA

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In recent years, the use of operant conditioning in animal husbandry has become an accepted practice in many zoos and aquariums. The use of behavioral conditioning can greatly reduce the risks and stress associated with animal care procedures while making these procedures safer for both animals and keepers. Training is a particularly valuable tool when dealing with a high maintenance, potentially aggressive species such as the sea otter. This presentation will illustrate methods employed at the Monterey Bay Aquarium, Monterey, California, USA, to incorporate training into southern sea otter husbandry. The benefits of safe, effective husbandry behavior training and how to initiate a training program will also be discussed.

WEIGHT CHANGES OF SEA OTTERS IN GESTATION PERIOD AND ESTIMATING DELIVERY DAY, OSAKA AQUARIUM, OSAKA, JAPAN

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Generally, captive sea otters are weighed on a scale by putting them in a cage. Due to this animal's sensitivity, however, it is difficult to weigh them frequently with this method, especially when pregnant. At the Osaka Aquarium, Osaka, Japan, we trained sea otters in captivity to get on the scale by themselves. All of them were weighed successfully and now it is possible for us to weigh them once or more in a week in order to check their health condition.

So far, 4 pregnancies (including one stillbirth) of two female sea otters have occurred at Osaka Aquarium. We tried to continue weighing them until the day before delivery and got 4 data sets of weight change for the gestation period. Each gestation period was 186, 197, 191, and 191 days, respectively.

The data and observations showed that there were no major weight changes and no sign of pregnancy for first 2 to 3 months after copulation. At 4 months the weight increased obviously and fetal movement and protrusion of the nipples was observed. Weight kept increasing for about 2 months, then stopped 1 to 2 weeks before delivery date. The rate of weight increase during the period of gain was approximately 0.08 kg/day and was almost equal in 3 of the 4 pregnancies. By understanding the base weight and the rate of gain during a gestation period, it is possible to identify the approximate delivery date.

RESULTS OF SEA OTTER SURVEYS ON SOUTHERN KAMCHATKA *[п-ов Камчатка]* AND NORTHERN KURIL ISLANDS *[Курильские о-ва]*, RUSSIA, IN JUNE 1997

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A survey was conducted for 9 days, during the birth peak in early summer 1997. A small sailing yacht was used as the survey platform. The following table shows the survey results.

1997 (June) Survey Results		
Region	Count	Comments
South Kamchatka *[п-ов Камчатка]*	1,000+	
Eastern Paramushir Island *[о. Парамушир]*	2,000+	primary concentration at northern and southern ends
Shumshu Island *[о. Шумшу]*	8,000+	unexpectedly large number; largest number of females & pups (majority in the strait between Shumshu and Paramushir)
Total	>13,000	

Historic Survey Results			
Year	Count	Platform	Comments
1987	2,015	aerial	winter
1988	2,367	aerial	winter
1989	10,000 to 15,000	aerial	
1990	7,000 to 7,500	aerial	know that animals were missed
1997	13,521	vessel	(June) 12,387 to 15,133 adults; 1,134 pups

It is estimated that a total of 21,925 to 23,000 sea otters occur in Russia waters. About 80-90% are in the southern Kamchatka Peninsula / Cape Lopatka *[м. Лопатка]* region.

RESULTS OF SEA OTTER TAGGING ON KAMCHATKA PENINSULA *[п-ов Камчатка]* AND COMMANDER *[Командорские о-ва]* AND KURIL ISLANDS *[Курильские о-ва]*, RUSSIA, IN 1996 AND 1997, AND FUTURE PERSPECTIVES

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The goals of this project included tagging the maximum number of individuals throughout the sea otter's range. The resighting information will be used to understand population demography and movement data. Resighting of tags will also provide an opportunity to study age and sex ratios, continuity of distribution within and between populations, and mortality and survival rates. Tagging is generally conducted in the winter, 1 March until 15 April, while animals are on haul-outs. Once the weather warms, sea otters come to shore less often, preferring instead to rest in kelp areas. Small groups of animals are targeted, particularly at dawn and dusk. Females with pups are avoided. Dipnets are often used. Fur seal tags, Rototech tags, and Temple Tags have all been used; colors include pink, olive, orange, and blue.

Commander Islands *[Командорские о-ва]*: Tagging began in the 1970s, but the overall number of tagged individuals was low in the first decade. Throughout the early 1980s, up to 100 sea otters per year were tagged at the south end of Medny Island *[о.Медный]*. Efforts moved to Bering Island *[о. Беринга]* (north and southeast island areas) in the second half of 1980s. Logistics currently preclude additional tagging or monitoring of the tagged animals, but movement is known between the islands (50 k.).

Kamchatka Peninsula *[п-ов Камчатка]*: Tagging was attempted in the southern region in 1984, 1989, and 1997. In the middle peninsula area in August 1997, 83 adults and 43 juveniles were tagged at Cape Kamchatka *[м. Камчатский]* and Cape Afrika *[м. Африка]* which is the far northern terminus of the historic range of sea otters. A group of sea otters has been present in this region since the mid-1980s. A growing number of pups have been seen to the south at Cape Kronotski *[м. Кроноцкий]*, but ice conditions there are challenging for both tagging and monitoring and sometimes drive otters out of the area.

Southern Kuril Islands *[Курильские о-ва]*: Small numbers of tags were placed between 1990 and 1997.

Future tagging efforts should include several locations in the Commander Islands: Northwest Cape *[м. Северо-Западный]* and Cape Tolstoy *[м. Толстый]* on Bering Island and South Cape *[м. Южный]* and the northern end of Medny Island. Some of the larger bays on southern Kamchatka Peninsula and Ytashud Island *[о. Уташуд]* may also be suitable. In the Kurils, the capes on Shumshu Island *[о. Шумшу]* are good locations.

Initiation of a Sea Otter Training Program

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Since 1990, the John G. Shedd Aquarium of Chicago, Illinois, USA, has housed five Alaskan sea otters (*Enhydra lutris*). All five otters were orphaned, rehabilitated pups that were brought to the aquarium in 1989 and 1990. During their rehabilitation, the otters became accustomed to human attention, which was helpful in their early handling. As the otters grew, there was concern over the possibility of increased aggression in older animals.

This paper focuses on the transition to formalized training with our sea otters. Through the use of standard training techniques, we have had some excellent results, particularly with husbandry behaviors. Sea otters presented the training staff with unique training challenges. We will describe the various steps taken to implement a formal training program, as well as examine mistakes that should be avoided if initiating such a program. Ultimately, we hope to point out the advantages we've seen by introducing our otters to formalized training.

DAILY ACTIVITY TIME BUDGET AND PREY COMPOSITION OF SEA OTTERS ON MEDNY ISLAND *[о. Медный]*, RUSSIA

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Time activity budgets and prey composition were evaluated for sea otters in Medney Island's *[о.Медный]* Glinka Bay *[б. Глинка]* in Russia's Commander Islands *[Командорские о-ва]*. Scan sampling was done at 20-minute intervals between 21 June 1995 and 29 August 1995 during the hours of 0800 to 1900. Recorded categories of activity included feeding, resting, feeding pups, movement, mating, and others. During a total of 148 hours, 2258 animals were observed.

Results of prey composition: 82% urchins, 16% sandlance, and 2% other. Two daily peaks of feeding activity were observed (early morning and early afternoon). Resting activity generally occurred between 0900 and 1400 hours.

Fish generally were consumed during the early feeding bouts which coincides with their availability in the midwater column. Sandlance typically are in the midwater column at night and drop into deeper water or sediments during the day. This is similar to the feeding pattern observed in California and Amchitka Island although bivalves are the primary prey source in these areas.

It is postulated that peaks in feeding activity may be related to the sea otter's ability to forage in kelp areas. At low tides, kelps form dense aggregations in the water column, whereas at high tides, kelps are less dense. Additionally, since sea otters tended to rest in kelp areas, attractiveness of a single area for both resting and feeding can influence location choice. Other factors which may influence feeding times could include tidal level and weather.

Time activity budgets can be characterized as follows: males - resting 39%, feeding 27%; females - resting 41%, feeding 35%. On average, sea otters in this study were feeding 30% of the time. An abundance of prey in this region supports high densities of sea otters without an increased cost in foraging time and effort.

MONTEREY BAY (USA) AQUARIUM'S SEA OTTER RESEARCH AND CONSERVATION PROGRAM HISTORY, STATISTICS, AND RELEASE OUTCOMES: JANUARY 1984 - SEPTEMBER 1997

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The Monterey Bay Aquarium, Monterey, California, USA, began treating and caring for sea otters in 1984 with four abandoned pups who were raised as captive animals for our sea otter exhibit. After these first four otters were successfully raised, other animals continued to arrive at our doorstep. Between January 1984 and September 1997 the Monterey Bay Aquarium has received and cared for 136 ill, injured, or abandoned sea otters of all age classes. More than half, 55.9%, have been young pups (0-20 weeks of age); 26.4% have been adults (>3 years of age); 13.9%, have been weaners, (21- 4 weeks); and the remaining 3.8% have been juveniles (35-52 weeks) and sub-adults (1-3 years of age).

Injured or sick adults, sub-adults, and juveniles are either cared for over several months and easily returned to the wild or die in house. Some early weaners are also readily returned to the wild after being held in a tank, given time to improve their foraging skills and to gain weight. Of the 136 otters received at the aquarium for treatment, 51.4% (n=70) died or were euthanized in house within the first two weeks or less of arrival. Their injuries were too severe or the animals were in too weakened a state to survive initial treatment. Some of the causes of death included trauma, parasites, old age, and shock.

The remaining 48.6% (n=66) sea otters were raised either as captives or as animals to be re-introduced to the wild. Preparing animals for re-introduction included raising them in an outdoor tank either alone or with other animals of similar size, or in the swim program which provides a pup with a human caregiver. The caregiver teaches each pup foraging skills with daily swims out in the open ocean. Using the aquarium's definition of success (survival in the wild for two weeks or longer), of the 41 pups and weaners returned to the wild 53% have been successful.

INTERNATIONAL TRANSPORT OF SEA OTTERS

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In recent years, many aquariums have opened and/or are opening with the intention of displaying sea otters as a main exhibit. Most, if not all, of the sea otters are coming from Alaska, USA. In a majority of cases, this involves a very long transport, with many logistical complications. This paper will address the capture, transport, and final disposition of five sea otters relocated to Lisbon, Portugal, and St. Malo, France, in September 1997. Recommendations will be given for both the permitting agencies and private collectors and/or aquariums that wish to collect these animals in the wild.

AN UPDATE ON THE CAUSES OF MORTALITY IN SOUTHERN SEA OTTERS

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From 1992 to 1996 the causes of mortality in southern sea otters were studied by examination of 247 freshly dead beach-cast carcasses found along the coast of California, USA. Each animal received a complete postmortem examination and additional laboratory tests that were selected on the basis of examination findings.

Approximately 40% of the deaths were caused by infectious diseases, 20% by various traumatic injuries, 9% of the otters were emaciated and had no other abnormalities, 13% died from miscellaneous conditions such as gastrointestinal obstructions, and the cause of death was undetermined in 18%. The causes of infectious diseases were varied and included parasites, bacteria, and fungi. The sea otters dying from diseases were primarily postweaning juveniles, subadults, and adults.

A high frequency and variety of infections may suggest a lack of resistance to infections, so liver tissue from a subset of the otters that died from infections, as well as other causes, were analyzed for traces of butyltins, a potentially immunosuppressive class of fumigants used in marine anti-fouling paints. Butyltin residues were detected in southern sea otter tissues; the mean concentration found in otters that died from disease were higher than in those that died from acute traumatic injuries. There is much yet to be determined regarding the effects of pollution on the southern sea otter population, but these results indicate that the role of immunosuppressive environmental contaminants warrants further investigation.

SEA OTTER POPULATION DECLINE IN ALASKA'S WESTERN ALEUTIAN ISLANDS, USA: AN OVERVIEW OF TRENDS, EFFECTS, AND POSSIBLE CAUSES

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Population data collected during a 1995-96 study at Adak Island, Alaska, USA, indicate a precipitous decline in sea otter numbers. Further surveys conducted in July-August 1997 at Adak and various other sites in the Aleutian archipelago confirm this trend. The resolution of these data is highest at Adak Island, where it appears that a reduction in numbers of 70% or more occurred between 1991 and 1997. The instantaneous rate of decline for this period ("r", based on the exponential growth model "N(t)=N(0)e^r(t)") was calculated as -25% per year (R^2=0.976, SE=0.022, P<0.001).

Survey data from Kiska, Kanaga, and Amchitka Islands, although less precise, indicate that numbers have dropped at an equivalent rate at these locations, and suggest a widespread population decline.

While the cause of this decline is still unclear, benthic surveys conducted at Adak and Amchitka Islands in 1987 and repeated in 1997 show dramatic increases in the size and abundance of sea urchins and a resultant decline in kelp density over the past 10 years. These data, in conjunction with data on demographics, diet, and activity budgets collected at Adak Island, suggest that the cause is not food limitation. Instead, data are more consistent with a density-independent removal of sea otters from the system.

We present two potential explanations for the population decline: 1) increased mortality and/or reproductive failure resulting from high blood contaminant levels, and 2) increased mortality resulting from predation by killer whales *(Orcinus orca)*.

Food Consumption Rates by Captive Wild Sea Otters

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Between 1987 and 1991, 139 sea otters were translocated from the mainland California (USA) population to an experimental colony off the coast at San Nicolas Island. Captive wild otters were brought to the Monterey Bay Aquarium for holding prior to translocation. The "holding phase" of the translocation allowed evaluation of the health of captive animals, and allowed animals to accumulate such that air transport to San Nicolas Island was more efficient and cost-effective. Here I utilize holding phase data to provide a new estimate of feeding rate in wild sea otters in California.

Captive otters were held in pools in the aquarium's quarantine facility. Pools were circular, 6.1 m in diameter, with walls 1.5 m in height. Water depth was 0.6 m. Pool water was fresh-filtered sea water at temperatures of 10-15 degrees C. Pool water turnover time was about 1 hour.

Captive otters were fed commercially available siphons of the geoduck clam (*Panope generosa*), whole market squid (*Loligo opalescens*), and live rock crab (*Cancer antennarius*). Initially, equal amounts of each food type were offered to captive otters. Proportions were adjusted based on observed feeding preferences for each group of otters. Based on available data in the ecological literature, initial quantities of food offered were about 25% of the summed body mass of captive otters per day. Typically there were 4 feedings per day, each totaling 5-10% of summed otter body mass. Quantities of food offered were adjusted based on observed consumption rates.

Quantity of food offered was determined directly with a balance, or indirectly by previously-calibrated volumetric equivalent. Uneaten food was removed with a long-handled pool-cleaning net, typically 2-3 hours after it was apparent that otters had stopped feeding. Uneaten food was immediately weighed, and a rate of consumption per unit of live otter mass was computed. The data allowed computation of feeding rate for 23 separate groups of sea otters between 28 September 1988 and 13 September 1989. Mean group size was 3.1 animals (range: 1-9). Mean time duration per group, over which feeding rate was estimated, was 18.4 hrs (range: 7.5 - 39.8).

The calculated mean feeding rate for the 23 study groups was 16 gm of food per kg of live otter mass per hour (range: 7-30 gm). This estimate converts to a mean feeding rate of 38.4% of summed whole otter body mass per day (range: 18-73%). The estimate indicates a rate of feeding higher than previously published estimates, and also suggests substantial variance among individuals in feeding rate. The difference between this estimate of feeding rate and those previously published could result from systematically biased measurement errors, although this is unlikely. Inclusion of relatively indigestible prey body parts, such as crab exoskeletons, also could cause a positive bias in the rate estimate. It is also possible that captive otters elevate feeding rate because of captivity-related stress, although this also seems unlikely and counter-intuitive. Finally, it is possible that wild otters in California are exposed to chronic food shortage in nature, and elevate intake rate as compensation when presented with unlimited food.

Estimation of Pre-Exploitation Sea Otter Population Sizes in the Northwest Pacific Ocean Using Archival Harvest Data and Modern Population Growth Data

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Directed harvests by indigenous peoples and incidental take in fisheries are among the factors contributing to the need for determination of maximum take levels tolerable by sea otter populations. Carrying capacity (K), necessary for such determinations, is unknown for many sea otter populations, however, and in some cases is in dispute for populations requiring immediate formulation of take limits. Here we report results of a new approach to the estimation of K for sea otter populations, combining archival harvest records with modern data on population growth characteristics. We utilize Russia's Commander Islands *[Командорские о-ва]* as a case study.

Sea otter populations were hunted to near extinction in the Commander Islands between 1741 and 1757. Archival records describe 11 harvesting expeditions to the Commander Islands with a total take of 8,226 individuals, beginning with the Bering Expedition of 1741-42 and concluding with the Boris and Gleb Expedition of 1752-57. The latter found virtually no surviving sea otters in the Commander Islands.

Sea otter populations off the Commander Islands were surveyed annually from 1979 through 1995. In 1992 numbers stabilized at about 4,400 animals, the apparent modern carrying capacity. We fitted a logistic growth model to the modern survey data. We treated each expedition as an instantaneous mortality event, of magnitude specified in the archives, and allowed the population to recover between expeditions according to a plausible range of parameter values. We obtained extinction at the approximate time of actual apparent local extinction, as observed by the Boris and Gleb Expedition, for parameter values similar to those obtained. We conclude that archival harvest records may be a useful approach to estimation of K for sea otter populations if record quality is sufficiently high.

SEA OTTERS OF YTASHUD ISLAND *[о. Уташуд]*, KAMCHATKA PENINSULA *[п-ов Камчатка]*, RUSSIA

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Sea otters were observed and skulls collected during a 14-day visit in February 1997 on Russia's Ytashud Island *[о. Уташуд]* in Vestnik Bay *[б. Вестник]* along the southeast coast of southern Kamchatka Peninsula *[п-ов Камчатка]*. About 300 sea otters were counted. They fed in a broad band around the island, but only hauled out in about 3 places at night or when stormy. Females with pups were seen off the north end of the island; males frequented the south end. If the ice pack surrounds the island, the otters leave for open water at the edge of the ice. Orcas *(Orcinus orca)* were observed and seemed to be hunting, but no sign of kills were seen.

POPULATION GROWTH AND EXPANSION IN CANADA'S BRITISH COLUMBIA SEA OTTER POPULATION

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Sea otters were reintroduced to the west coast of Vancouver Island, British Columbia, Canada, from 1969 to 1972. A total of 89 sea otters captured from Amchitka Island and Prince William Sound, Alaska, USA, were released in a series of three introductions. Since that time the population has grown at a rate of about 18.6 % per year.

The population along the west coast of Vancouver Island includes more than 2,000 animals. A smaller group of sea otters located 150 km north of Vancouver Island includes an additional 259 animals (1996). The origins of this group are uncertain. Both groups of otters are expanding their ranges. The Vancouver Island sea otter population ranges from Estevan Point half way up the west coast of Vancouver Island to Cape Scott at the northern tip. There are increasing reports of sea otters along the northern portions of the east coast of Vancouver Island. Although portions of the population appear to be at equilibrium density, high variability between counts has made it difficult to demonstrate this.

Changes in Community Structure Associated with Sea Otter Foraging in Shallow Rocky Areas off Northwestern Vancouver Island, Canada

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Community changes associated with sea otter foraging have been monitored since 1987 off the northwest coast of Vancouver Island, British Columbia, Canada. Four permanently marked sites were established prior to the arrival of sea otters and changes associated with sea otter foraging were monitored directly. Temporal variability in community composition was monitored concurrently at two sites in areas without sea otters and at two sites with sea otters.

The sites without sea otters were dominated by urchins, sea urchin abundance varied little, and fleshy algae remained rare. The two sites with sea otters were initially dominated by stipitate kelps, but underwent dramatic changes in species composition possibly associated with long term-changes in community structure. Sites occupied by sea otters during the study changed from being urchin-dominated to algal-dominated. The rate and pattern of community change was influenced by the frequency, intensity, and season of sea otter foraging.

Sites where sea otters foraged intermittently changed gradually because the spatial distribution of sea urchins changed in response to urchin tests discarded by foraging sea otters. This resulted in an initially patchy assemblage of algae composed of plants of different ages and successional stages. Where sea otter foraging was intense, algal communities changed rapidly. Long term successional processes appear predictable, but have been affected by large-scale climate events.

Appendix D

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