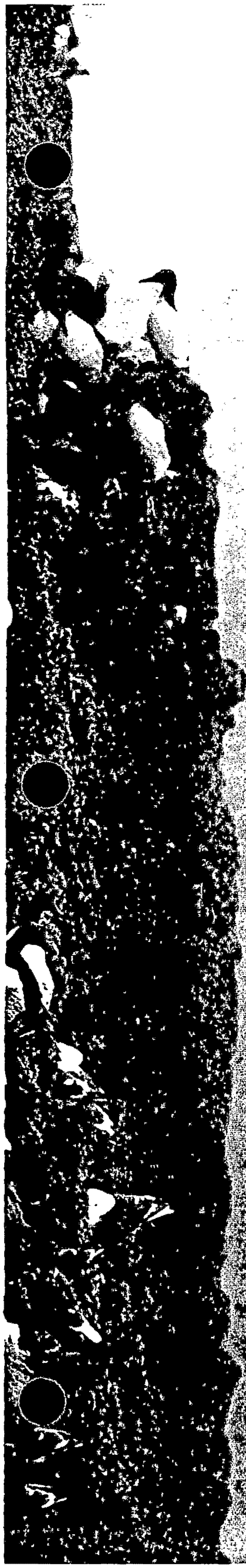


CONCEPT PAPER

Bering Sea Summit 2002

April 22-26, 2002; Egan Center, Anchorage Alaska

Proposal

The U.S. Environmental Protection Agency (EPA) proposes to join with other federal and non-federal partners in convening a Summit to define a sustainable future for the Bering Sea, a region that includes the Sea's associated terrestrial, freshwater and marine ecosystems. Now in the early stages of conceptualizing the meeting, EPA seeks partners who will join in determining the purpose and structure of the Summit, and assume joint responsibility for implementation.

Why Another Meeting?

Many meetings have been convened over recent years that feature one aspect or another of the Bering Sea, including public hearings, planning meetings, and discussions about fisheries management, scientific research programs, subsistence concerns, public health, and environmental change. Why the need for yet another meeting?

The principle behind holding a Summit is to build common goals and align efforts to address change in the Bering Sea. No single management organization, agency or commercial interest is responsible for, or on its own can alter the course of change. Success is possible, however, through a larger community effort where Bering Sea interested parties are partners in the design and plan of action for achieving a sustainable Bering Sea. We believe the Summit can fulfill a unique and vital role. It will help empower the full diversity of interests to join in defining a common direction and creating a more comprehensive plan of action that builds upon and helps knit together the fabric of work already accomplished.

Need

The Bering Sea, composed of the marine environment and the large river watersheds, terrestrial ecosystems and atmospheric pathways directly influencing its character, is one of earth's most productive marine ecosystems. It contains one of the world's richest assemblages of seabirds, marine mammals and large stocks of forage and commercially valuable fish and shellfish. It also supports a rich diversity of human commerce ranging from subsistence harvest to industrialized fishing and development. Now, natural forces and human influences are combining to change the character of the Bering Sea. Increasing contaminant levels, climate change, fishing pressure, energy development, and alteration of habitats are impacting the Bering Sea ecosystem in ways not fully understood.

Rapid change in the Bering Sea is equally obvious to scientists and those whose lives and livelihoods are directly linked to the Sea's productivity. Large persistent summer blooms of coccolithophores, major increases in jellyfish, declines in forage fish abundance, a northward shift of pollock, marked decreases in returning salmon, emaciation and massive die-offs of migrant shearwaters, major declines in Northern fur seals and seabirds in the Pribilofs, and significant declines in Steller sea lions are all compelling indicators of an ecosystem undergoing profound change. While change is natural, marine mammal and bird population declines between 50% to 90% within 20 years marks an ecosystem at risk

A fresh approach is in order to protect the natural riches of the Bering Sea along with the lives and livelihoods its abundance supports. This approach must be founded on collaborative action as well as greater scientific understanding to provide our best opportunity to influence the course of change. We believe it is time for all members of the Bering Sea community to join in a common drive to ensure the long-term sustainability of the Bering Sea ecosystem.

Summit Purpose and Outcome

The Summit's proposed purpose is to operationally define a sustainable future for the Bering Sea region that can be embraced by the highly diverse and often competing interests in the region. These interested parties include but are not limited to Tribes, rural communities, federal and state agencies, and commercial, environmental, recreational, and research communities, foreign and domestic. The Summit can accommodate from 500 to 1000 participants to ensure the potential for exchange within this large community.

The proposed theme behind the Summit is to foster dialogue that results in a multi-party shared vision and strategic framework for protecting and utilizing Bering Sea resources. Specific results within that framework might include:

- a shared definition of a sustainable Bering Sea with desired environmental outcomes;
- new and strengthened partnerships and alliances across previously competing interests to achieve common ends;
- action plans to achieve defined outcomes that includes who, what and when.

The outcomes of the Bering Sea Summit 2002 will ultimately be determined by those who convene, design and participate in the Summit.

Conveners of the Summit

EPA's interest in the Bering Sea region derives from the nature of its mandate and the establishment in 1998 of the *Bering Sea Regional Geographic Initiative*. EPA strongly supports collaborative community interaction and consensus building as a positive means to achieve its mission to "protect human health and safeguard the natural environment." The Regional Geographic Initiative is specifically intended to promote community-based environmental protection for the Bering Sea region, awarded in response to concerns about the impacts of rapid change in the Bering Sea on ecological resources, human health, subsistence cultures and economic stability.

EPA fully recognizes the essential role of others in any Bering Sea related effort. Many federal and state agencies have direct management responsibility for marine, freshwater and terrestrial resources. Tribes have specific rights to resources under federal law. Others such as Native corporations, villages, commercial enterprises, scientific and environmental organizations, both national and international, are also key interested parties. All interests need a voice at the Summit and Conveners should reflect this diversity. Thus, EPA is serving as a catalyst for the proposed Bering Sea Summit, but would like to transition quickly to partner with other interested Conveners to define the scope and structure of the Summit, and establish a Steering Committee for its implementation.

Summit Agenda

It is premature to specify a day-by-day agenda for the Summit. However we anticipate the core of the Summit agenda to include professionally facilitated caucuses within and across constituency groups to define common ground and potential actions. In addition, we anticipate convening the *First International Symposium on*

Integrated Assessment for a Sustainable Bering Sea in conjunction with the Summit as the principal forum for caucusing among the scientific community. Other elements for the Summit may include:

- keynote speakers that set the stage for important discussions;
- plenary sessions to bring together ideas developed in discussion groups and caucuses;
- an exposition of new technologies
- a student science and art fair to engage youth, and
- other activities that further the purposes of the Summit to bring diverse interests together.

The most challenging aspect of creating the Summit's agenda will be ensuring effective dialogue within and among interest groups. This will be a primary task of the Steering Committee established by the Conveners.

Funding

EPA allocated over $225,000 to the Summit. The Meridian Institute, a specialist in collaborative processes, received funding under a cooperative agreement to help form and manage the Steering Committee and facilitate the Summit. Science Applications International Corporation (SAIC) is under contract to handle Summit logistics. These are well under way.

Please Partner With Us!

Partnerships and resources are needed to make the Summit a reality. We hope to provide travel funds to key participants that need financial assistance and to require only nominal registration fees. You are a vital partner in making this possible!

Pages 1

AMERICAN LAND CONSERVANCY

KODIAK BROWN BEAR TRUST

ROCKY MOUNTAIN ELK FOUNDATION
Working for Wildlife

MEMORANDUM

TO: EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL, AUGUST 6, 2001

FROM: AMERICAN LAND CONSERVANCY (ALC), KODIAK BROWN BEAR TRUST (KBBT), ROCKY MOUNTAIN ELK FOUNDATION (RMEF)

RE: AFOGNAK ISLAND STATE PARK

ALC, KBBT and RMEF are grateful for the opportunity to address the EVOS Trustee Council at your August 6th meeting. Our presentation will make a compelling case for a significant matching fund commitment by the EVOS Trustee Council to complete the Afognak Island State Park through the purchase of additional EVOS ranked parcels in Perenosa Bay and the timber reservations within parcel AJV03a.

We recognize in advance of this opportunity that the EVOS Trustee Council has limited funding for habitat protection (approximately $25 million). We recognize that the EVOS Trustee Council has envisioned an endowment program designed to fund future habitat work on small parcel acquisitions. We also recognize that the EVOS Trustee Council has invested heavily in the Kodiak Archipelago and that use of any additional EVOS funds on Afognak Island would have to be very well leveraged in order to be competitive.

The opportunity to use EVOS Trustee Council funds to leverage massive investment by private charitable foundations combined with a narrow window of opportunity to work with numerous Native Corporation interests may be the most compelling conservation opportunity in the spill region today.

We at ALC, KBBT and RMEF look forward to sharing more details about this opportunity with the EVOS Trustee Council on Monday August 6, 2001.

Contact Information:

Glen Williams
Vice President
American Land Conservancy
1388 Sutter Street, Suite 810
San Francisco, CA 94109
tel (415) 749-3020
fax(415) 749-3011
glen@alcnet.org

Alan Christensen
Vice President - Lands
Rocky Mountain Elk Foundation
PO Box 8249
Missoula, MT 59808-8249
tel (406) 523-4500
fax (406)523-4581
achristensen@rmef.org

Tim Richardson
Executive Director
Kodiak Brown Bear Trust
6707 Old Stage Road
North Bethesda, MD 20652-4329
tel (301) 770-6496
fax(301)770-6497
trs@erols.com

Klamath Basin Wetlands Restoration

By Lauren Ward

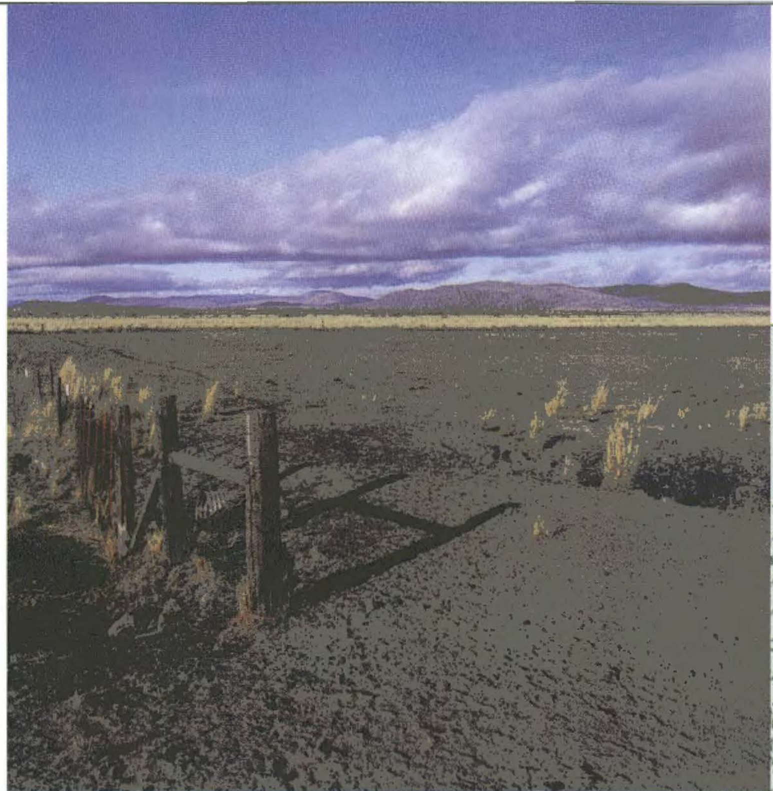
The National Wildlife Refuges of the Klamath Basin, located in Northern California and Southern Oregon, are regarded by many as the crown jewels of the refuge system. Nearly all of the 20,000,000 ducks and geese in the Pacific Flyway stage and pass through the Klamath Basin. Countless other non-game species of water birds, such as swans and sandhill cranes, also use the Klamath Basin and its refuges. The Klamath River is critical habitat for Coho salmon, steelhead and largemouth suckerfish (the traditional food source for the indigenous people of the area), and is host to the largest population of bald eagles in the lower 48 states.

In the 1940's, the US Bureau of Reclamation commenced draining the vast, federally owned wetlands of the Klamath Basin, converting them into irrigated farmlands. The "Klamath Project" diked and drained the land, leased it for farming and eventually sold fee title to individual farmers who were promised irrigation water from the project.

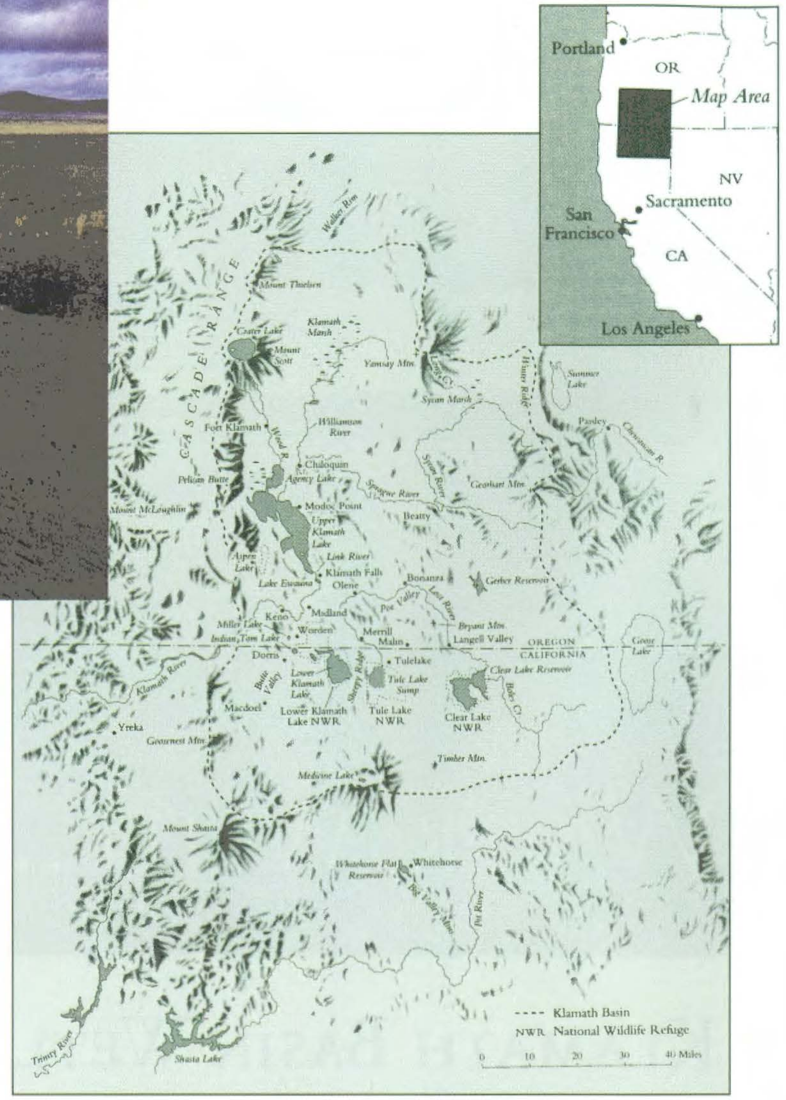
In the late 1950's and early 1960's, pressure grew to save wetlands for wildlife refuges. In 1964, Congress enacted the Kuchel Act, named for California Senator Thomas Kuchel, halting further land dispositions and protecting the last remaining wetlands. An unusual feature of the Kuchel Act provided for the permanent leasing for farming purposes of 22,000 acres of refuge land with 25% of those leased lands to be devoted to row crops such as potatoes, sugar beets, garlic and mint. Significantly, the "leased lands" are the lowest lands on the refuges and before they were used for farming, provided storage for surplus water during the spring runoff period.

Unfortunately, the water supply during the irrigation season in the Klamath Basin is insufficient to meet the needs of the endangered species, Native Americans, farmers and the refuge. Worse yet, the priority for water distribution

continued on page 2



front cover: Mount Dome, Lower Klamath Lake, CA
above: Before Restoration, Klamath Basin, CA
(photos and map from *Balancing Water Restoration, The Klamath Basin,* © 2000 Tupper Ansel Blake and Madeleine Graham Blake)



Restoring the Klamath Basin

continued from page 1

places the National Wildlife Refuges last, behind farmers. During an average water year the refuges are seriously short of water, even as 22,000 acres of refuge lands are farmed with irrigation water from the Klamath Project. During dry years, the refuges face the complete loss of their water supplies. Although adjudication of water rights is currently in process, claims for more than 200% of the available supply have been filed, and it is expected to take up to 30 years before all court actions are completed.

Solving this problem is an extremely high priority for the U.S. Fish and Wildlife Service and the environmental community. ALC is currently working to acquire approximately 22,000 acres of farmland from willing sellers, making it available as a substitute for the leased lands on the refuges. Thus, farmers who had been working the leased lands would be moved to the newly acquired land, and sellers who wish to retire from active agriculture would be provided a buyer for their land. Once those leased lands are removed from production, water demand in the Basin will be reduced by approximately 50,000 acre-feet of water, and storage space will become available for up to 100,000 acre-feet of water available in the spring.

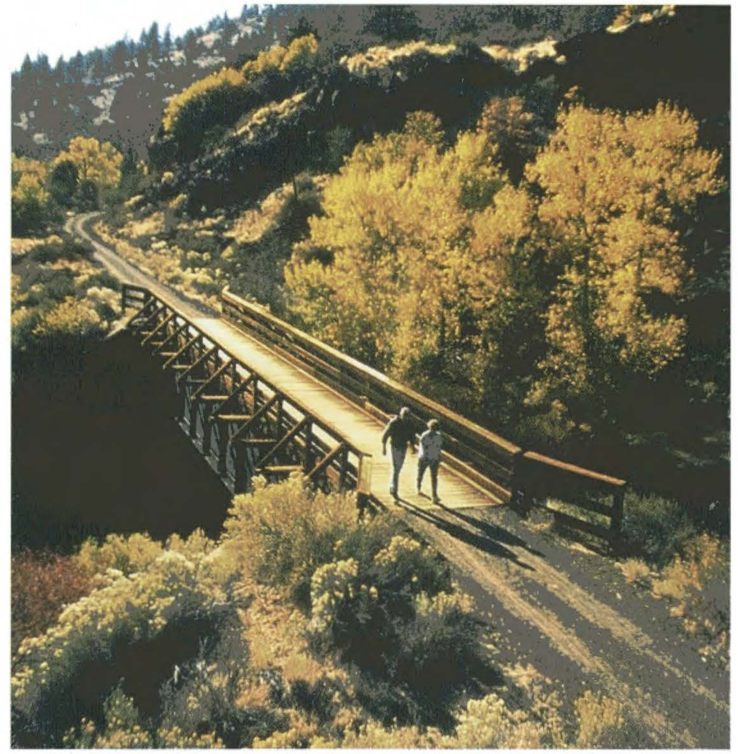
Currently, ALC has over 17,000 acres under option and is still recruiting more. The project will take at least two years to complete and will require enabling legislation from Congress to revise the Kuchel Act and provide funding. Federal partners include United State Fish and Wildlife Service and the Bureau of Reclamation. Non-federal partners include California Waterfowl Association, Ducks Unlimited, the Wilderness Society and a host of others interested in protecting water, fisheries, and refuges in the Klamath Basin. ✻

Bizz Johnson Trail

Susanville, California

By Kerry O'Toole

In the town of Susanville in northeastern California, bikers, hikers, runners, horseback riders and cross-country skiers can embark on a magnificent scenic journey along the Bizz Johnson Trail. Beginning at the rail depot in town, this trail stretches 30 miles west to the town of Westwood, following along the former route of the Fernley and Lassen



"Bizz Johnson Trail" near Susanville, CA (Photo by Stan Bales)

Railroad. Once a busy rail corridor used for transporting logs to the lumber mills in Westwood and Susanville, and milled lumber to Southern Pacific's main line in Nevada, the Bizz Johnson Trail is now one of the highlights of the national Rails to Trails System. For much of its route, the trail follows along the banks of the Susan River, passing through a magnificent, rugged and still undeveloped canyon that looks much as it did over 88 years ago when the rail line was constructed.

Railroad logging boomed in the early 1900s, and by the mid-1950s, the Westwood lumber mill had closed and the Susanville mills had switched to truck logging. In 1955, a flood damaged a railroad bridge in Susanville, and rail operation ceased, but the Southern Pacific didn't legally abandon the line until 1978.

The Bureau of Land Management (BLM) and the United States Forest Service (USFS), who manage land along the route, had the foresight to begin planning for acquisition of the right-of-way for recreational purposes in advance of the abandonment. With the help of ALC President Harriet Burgess, working then for the Trust for Public Land, the BLM was poised to purchase the railroad right-of-way when it was abandoned. Working with Congressman Harold "Bizz" Johnson and Southern Pacific Railroad, the right-of-way acquisition was one of only two BLM projects funded by Congress in 1980. Several years later, Congress named the trail after Bizz Johnson in honor of his efforts.

Once the right-of-way came into public ownership, the BLM was faced with the formidable task of acquiring the lands along the trail. Although the right-of-way was publicly owned, the trail passed through lands that largely had been subdivided into 5-acre lots. In order to maintain the trail's natural character, the BLM thus began the lengthy process of purchasing properties in the trail's viewshed.

When Harriet Burgess left the Trust for Public Land to form American Land Conservancy, she took with her the dream of completing public ownership of the land along the Bizz. In December 2000, ALC conveyed 95 riverfront acres to the BLM, bringing the total conveyance to over 270 acres. Thanks to prompt action by ALC, lands within the Susan River Canyon were saved from development.

Stan Bales, Outdoor Recreation Planner for the Susanville BLM who has been planning, managing and biking the Bizz Johnson Trail for 24 years, is elated the BLM can now shift its attention away from acquisition to other trail priorities. Jokingly, Bales refers to this new phase as "The Bizz Johnson Trail: The Next Generation." This stage of management will focus on interpretive aspects of the trail, bringing the human and natural history of the Bizz to life. Oral history interviews that Bales and the BLM recently initiated in partnership with the local land conservancy, Lassen Land and Trails Trust, will become part of the exciting future of the trail.

If you ever get a chance to bike along the Bizz Johnson Trail, stop for a picnic under the cottonwoods or take a dip in one of the Susan River's swimming holes, you will understand the enduring quest of Stan, Harriet and many others to protect the canyon. The Bizz Johnson Trail is one of California's hidden treasures that is well worth visiting. ✻

Bear Valley

Colusa County, California

By Daniel Waggoner

The Bear Creek watershed encompasses 65,000 acres of ecologically significant land in California's inner coastal range. A wealth of native plant communities can be found within the watershed, with over 400 species of plants documented in the area. Bear Valley, which occupies the northern portion of the watershed, is visited by thousands of people each year to view what has been described as "one of the grandest displays of lowland-field wildflowers remaining in northern California."

The diverse habitats in the watershed provide home to a rich array of wildlife, including 22 plants and animals listed by the California Natural Diversity Database, 14 of which are species "of concern." Herds of Tule elk are found on adjacent BLM land, and Caltrans has designated the surroundings to be a State Botanical Management Area. The 24-mile Bear Creek drainage is a rare aquatic ecosystem, supporting native fish, northwestern pond turtles, and yellow-legged frogs. Geothermal springs occur there and provide habitat for three endemic species of insect. Bear Valley also contains some of the only remaining examples of remnant, native prairie in the state.

In 1996, the California Native Plant Society brought the Bear Valley Ranch to ALC's attention. During the wildflower season, the 15,000-acre ranch, like the rest of Bear Valley, exhibits one of the most spectacular wildflower displays in California, with sweeping vistas of color covering several thousand acres. A remnant of the once extensive displays that carpeted the Central Valley, the Bear Valley palette changes with the seasons, influenced by the intensity and amount of rainfall. In addition to wildflowers, eight species of oak cover the surrounding hills.

In the early 1990s, Bear Valley Ranch was slated for development as the focal point of a new town. Due to a decline in the real estate market, those plans were defeated and the property went into foreclosure. However, when the real estate market improved in 1995, the Ranch went back on the market. At that time, the landowners explored the possibility of subdividing the Ranch and selling the smaller parcels to buyers who would have very likely changed the make-up of the ranch and destroyed the wildflower display. Thus, American Land Conservancy began working to ensure that the wildflowers and the Ranch would be protected. In 1995, ALC entered into a five-year option agreement to purchase approximately 15,000 acres of the valley.

On March 15, 2001, ALC closed escrow on the Bear Valley Ranch. Gabrielson Cattle Company, a conservation buyer, purchased the Ranch subject to a conservation easement generously funded by the California Wildlife Conservation Board and The David and Lucile Packard Foundation. At the close of escrow, ALC assigned the conservation easement to the California Rangeland Trust (CRT), who agreed to monitor the easement.

Pink Adobe Lily (Photo by Celia Zavatsky)

Now that Bear Valley Ranch is protected from development in perpetuity, the biggest threat to this unique watershed ecosystem is invasive plants. Yellow Star Thistle, Tamarisk, Perennial Pepperweed, Medusahead, Barb Goatgrass, Giant Reed and Tree-of-Heaven are some of the most troublesome and persistent of the invaders. These noxious weeds cause irreparable ecological damage—reducing the populations and halting their spread is critical.

To carry out this extensive job, University of California Range Ecologist Craig Thomsen worked with ALC to develop cooperative partnerships with 17 entities, including National Fish and Wildlife Foundation, the Bureau of Land Management, UC Davis, private companies, local landowners, a hot spring resort, an inmate work-training facility and other federal, state and county agencies. The primary objective of this collaborative effort is to control the exotic species that threaten the ecosystem through a combination of detection, eradication, containment, and management measures. Methods include an integrated approach of mowing, cutting, controlled livestock grazing, prescribed burning, herbicide applications, and manual control (pulling weeds). In concert with this program, the long-term aim is to improve the drainage of Bear Creek through grazing management and erosion control measures, and to raise public awareness about noxious weeds and ecosystem restoration.

Dedicated to removing the invasive plants, like the tenacious Tamarisk, and replacing them with native grasses and native wildflowers, Craig Thomsen and his team have logged many grueling hours of restoration work in the Bear Creek Watershed. Because of the severity of the invasion, restoration is expected to continue for at least the next few years. Funding for the work thus far has been made possible through grants from the National Fish and Wildlife Foundation's "Pulling Together" Initiative, and the many hours and dollars contributed by ALC's cooperating partners.

The wildflower season in Bear Valley begins in mid-March with the flowering of the unusual Adobe Lily. Although this plant occurs elsewhere in northern California, nowhere is it found in the profusion that exists in Bear Valley. Mid- to late-April brings fields of two types of Tidy-tips in combination with an extravagant mix of Poppy, Purple Owl's Clover, Lupine, Bird's Eye Gilia, Cream Cups, Monolopia, Larkspur and others. Rarities in the rockier parts of the valley include Purdy's Fringed Onion, Tracy's Clarkia and Jepson's Milkvetch, which usually bloom in May and June.

Wildflower enthusiasts from California and across the country make the pilgrimage to Bear Valley every spring to witness the spectacular show. The displays can be viewed from Bear Valley Road, but if you'd like a more intimate tour of the Valley and the chance to witness the fields up close, you can hop on a tour given by Jim Keegan, the owner of a neighboring ranch in the valley. To reserve call (707) 998-4471.

Lupine, Owl's Clover, and California Goldfield, Bear Valley (Photo by Robert Stephens)

Making Dreams a Reality in … ills

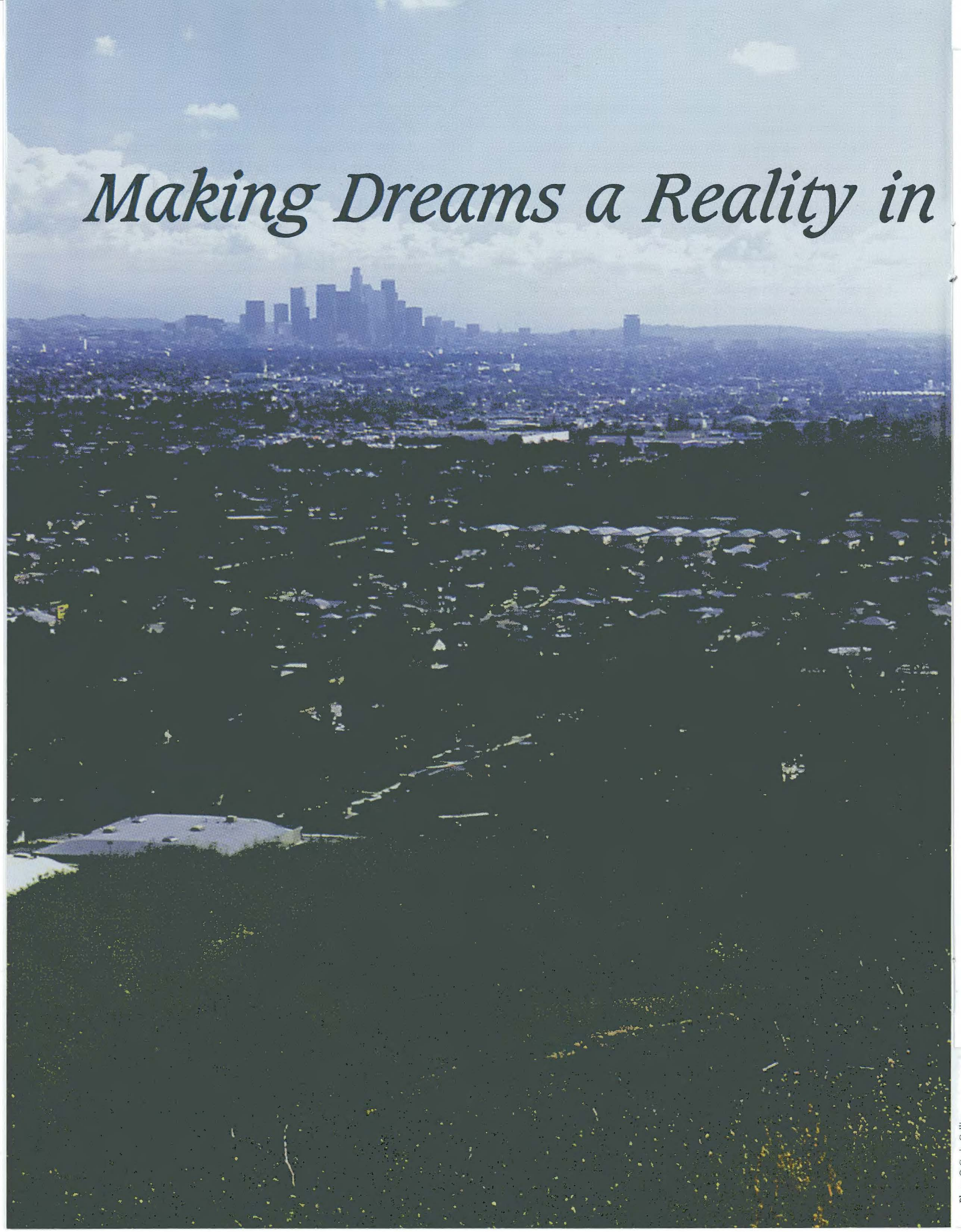
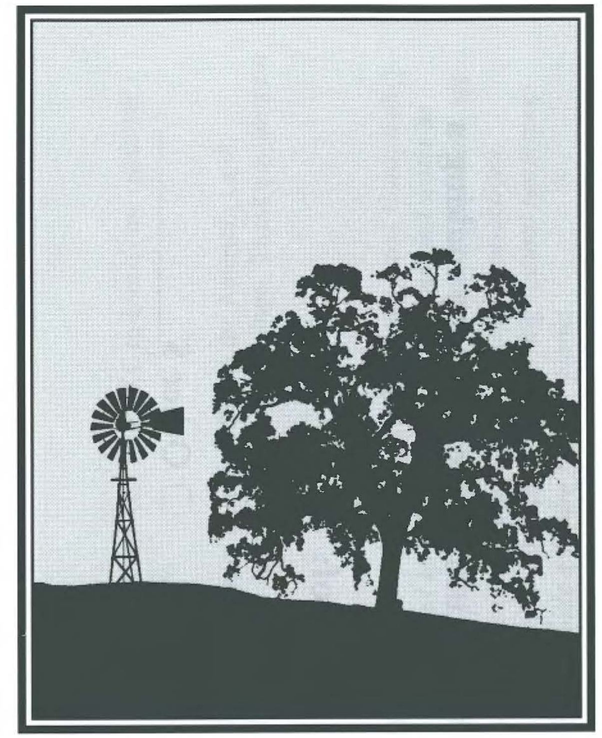


Photo © Craig Collins

By Jeff Stump

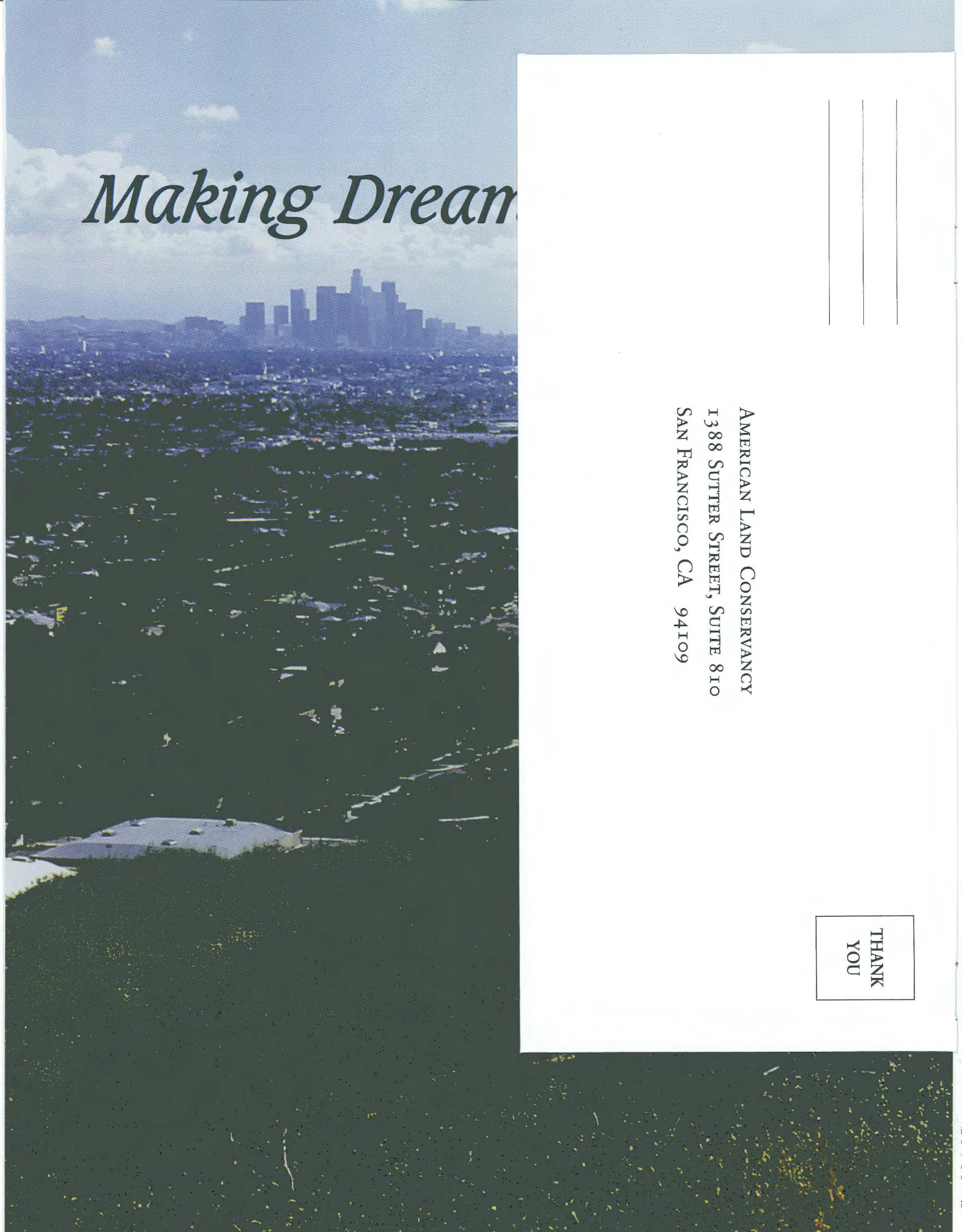


plans for "The Hill," an upscale, gated community, and sell the property to ALC for public benefit.

The acquisition of Vista Pacifica is the critical first step in the expansion of State Park land in the Baldwin Hills, and the creation of a new "Central Park" in urban Los Angeles that will provide all the benefits of a world-class recreational and natural area to the 10 million residents of the Los Angeles Basin.

Look for ALC and our partners to continue to be active in the Baldwin Hills as we strive to complete our vision of protecting natural areas and expanding public recreational opportunities through future acquisitions of existing oil fields as they phase out of use. ✷

Looking toward the ocean from Vista Pacifica
(Photo © Craig Collins)



Making Dream[s] … the Baldwin Hills

Los Angeles, California

By Jeff Stump

AMERICAN LAND CONSERVANCY
1388 SUTTER STREET, SUITE 810
SAN FRANCISCO, CA 94109

THANK YOU

Photo © Craig Collins

Long standing dreams of a new urban park in Los Angeles were realized on Friday, December 29, 2000, when escrow closed on American Land Conservancy's purchase and subsequent transfer to California State Parks and the Baldwin Hills Recreation and Conservation Authority of the 68-acre Vista Pacifica property. Located on the north-east corner of the Baldwin Hills, a small mountain range rising from the heart of the Los Angeles Basin, Vista Pacifica provides sweeping views of the Pacific Ocean, Hollywood Hills, San Bernardino Mountains and the Palos Verde Peninsula.

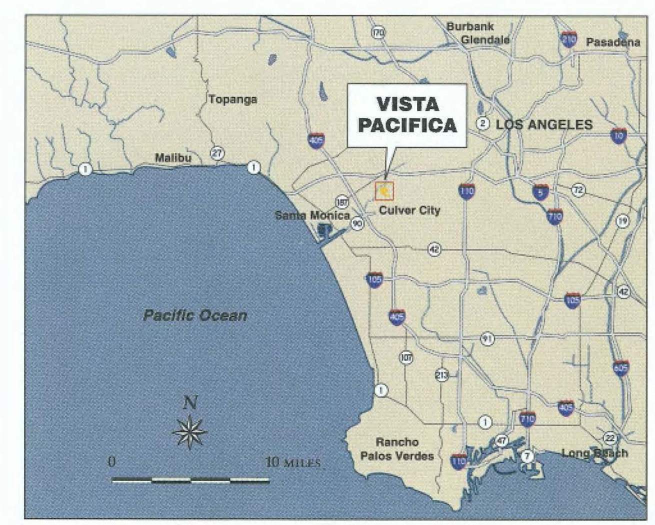
Many years in the making, the Vista Pacifica acquisition is a model for public/private agency partnerships. Community and park planning work completed by Community Conservation International and funded by grants form the Packard Foundation and Environment Now, laid the foundation for broad governmental support at the state and local levels. Passage of Proposition 12, the Kelley-Villagarosa "Safe Neighborhood Parks, Clean Water, Clean Air and Coastal Protection Bond Act of 2000," subsequent legislative appropriations engineered by Senator Kevin Murray and Assemblyman Herb Wesson, and Los Angeles County Proposition A funds secured by Supervisor Yvonne Brathwaite Burke made the $41.1 million project possible. An innovative acquisition team made up of staff and consultants from the American Land Conservancy, Santa Monica Mountains Conservancy, California Department of Parks and Recreation and the Baldwin Hills Recreation and Conservation Authority worked around the clock for four months to make the acquisition a reality.

Most important, however, was the unwavering support of Governor Gray Davis and the willingness of Security Properties and John Lang Homes to set aside their plans for "The Hill," an upscale, gated community, and sell the property to ALC for public benefit.

The acquisition of Vista Pacifica is the critical first step in the expansion of State Park land in the Baldwin Hills, and the creation of a new "Central Park" in urban Los Angeles that will provide all the benefits of a world-class recreational and natural area to the 10 million residents of the Los Angeles Basin.

Look for ALC and our partners to continue to be active in the Baldwin Hills as we strive to complete our vision of protecting natural areas and expanding public recreational opportunities through future acquisitions of existing oil fields as they phase out of use. ✸

Looking toward the ocean from Vista Pacifica
(Photo © Craig Collins)



☐ **YES!** I want to make a gift for the future of the Earth by making a gift to the American Land Conservancy.

Enclosed is my tax-deductible donation of:

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Please make your check payable to the American Land Conservancy and enclose in this envelope. Thank you for your support!

Founded 10 years ago, the American Land Conservancy is dedicated to the preservation of land and water as enduring public resources. As a national land trust, we specialize in complex and risky land transactions. Your gifts to ALC protect enduring natural resources, and provide a future for our planet.

6/01

Bridgeport Valley

Mono County, California

By Jacques Etchegoyhen

There still exist a few mountain valleys in California that have not yet succumbed to invasion by "ranchettes," 20-acre parcels created from the subdivision of large ranches formerly hundreds or thousand of acres in size. Along the escarpment of the Eastern Sierra, the Bridgeport Valley is the only reminder of what once was. Highway 395, from Minden, Nevada to Lone Pine, California, can still take one's breath away, and nowhere along the route is more breathtakingly beautiful than the Bridgeport Valley. This emerald meadow, originally known as the "Big Meadows," creates a stunning foreground for the "Sawtooth Ridge," the peaks which are the northern border for Yosemite National Park. Small glaciers still glisten below the ridge, and peaks with names like "Matterhorn," "Dragtooth," "Sawblade," "Cleaver" and "Three Teeth" beckon those with more adventurous callings.

Fewer than ten miles from the border of Yosemite, ranchers owning fully seventy percent of the 13,000-acre valley are working with the American Land Conservancy and California Rangeland Trust to place permanent conservation easements on this land to preserve the habitat and wetlands they've created. Through their land still migrates the largest mule deer herd out of the Eastern Sierra to the drier, winter range in the Sweetwater Mountains. The only remnant population of Walker Lake Lahontan Cutthroat Trout resides in a creek entering the valley, and another indigenous fish, the Paiute Sculpin, live in many of the creeks throughout the valley.

Bridgeport Valley, CA (Photo by John Lacey)

Bridgeport Valley, California (Photo by John Lacey)

According to Dr. Linda Vance, Director of Biological Science Programs at the University of California at Davis, the wetlands created by irrigation in this valley provide habitat unique to the West. In fact she says, "The Bridgeport Valley is utilized by researchers from UC Davis, UC Berkeley and UC Santa Barbara to obtain baseline data unavailable elsewhere in the West because of influences caused by human development." In essence, the Bridgeport Valley is a living laboratory that cannot be replaced. This is not about the conservation of a unique species; it is about the preservation of a unique system.

It is not certain why this valley has, so far, escaped the fate of so many other valleys in California. Certainly distance to Reno or Los Angeles, and to a year-round pass over the Sierra are factors. The climate proves difficult to some, including Mark Twain, who said about the area, "The region has two seasons, the breaking up of one winter and the beginning of the next." I suspect that a large part of the reason too, is that most of the valley is still held by six families, most of whom have a deep love for the land. They realize that in order to preserve what we all cherish about this valley, they will need to stand together.

Leaning on the hood of his truck, I recently said to an owner of 6,700 acres there, "You know, fifty ranchettes spread evenly across this valley would ruin it." John Lacey chuckled, and sagely responded, "Hell, five would." ✹

PROJECT UPDATE

Rancho Ventana

Monterey County, California

By Daniel Waggoner

Thanks to some creative financing on the part of ALC, a donation of land from the County of Monterey, a matching grant from The David and Lucile Packard Foundation and funding from the California Legislature through the Park Bond of 2000, the Pfeiffer Big Sur State Park was able to expand its popular park by more than 300 acres in December 2000. This addition to the park adds old-growth redwood groves intermingled with stands of tan oak, bay and madrone, and sweeping vistas of the surrounding mountains and the sea. The Rancho Ventana property will soon be a part of the State Parks planning process and, with public input guiding future uses, the property could provide additional trails for hiking. These new hiking opportunities could make connections to numerous other trails and provides controlled access to the Ventana Wilderness – which would provide for better fire control and public safety.

The dedication ceremony on December 7, 2000 at the Post Ranch Inn coincided with ALC's annual Board of Councillors retreat, enabling the Board and staff to attend. Also in attendance

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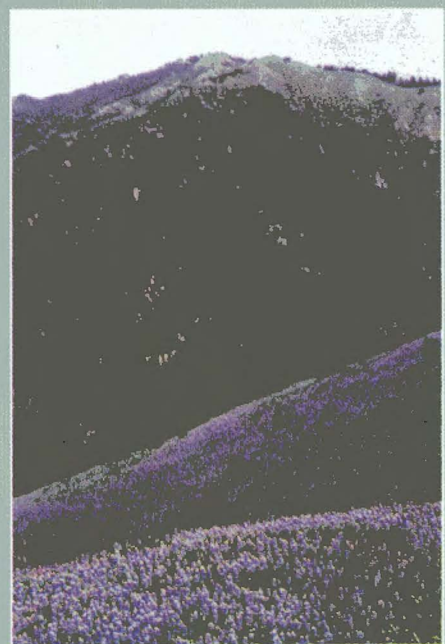


Rancho Ventana, Big Sur
(Photo Dr. Albert Kutcher)

ALC Receives $200,000 Grant for Afognak Island, Alaska

By Glen Williams

Sitka spruce rainforest on Afognak Island, Alaska
(Photo by Glen Williams)

The Paul G. Allen Forest Protection Foundation recently awarded $200,000 to the American Land Conservancy and its partners, the Rocky Mountain Elk Foundation and the Kodiak Brown Bear Trust, to help protect old-growth Sitka spruce forests on Afognak Island, Alaska. ALC will provide negotiating and land acquisition expertise for the project, Rocky Mountain Elk Foundation will assist with land acquisition and lobby to obtain public funding and Kodiak Brown Bear Trust will be the liaison to the Native Corporations that own the land.

With its rocky coasts, sheltered bays, old-growth Sitka spruce forests, prodigious salmon runs and rugged mountains, Afognak Island is one of the most spectacular and beautiful islands in Alaska. Its remaining old-growth forests, wetlands and more than 300 miles of coastline provide unparalleled habitat for more than 160 bird species, Kodiak brown bear and Roosevelt elk, while it's rivers and streams provide spawning ground for four species of Pacific salmon and habitat for Steelhead and Rainbow trout.

The Paul G. Allen Forest Protection Foundation supports projects that acquire forestlands and protect them from development and exploitation. Through land acquisition, the Foundation endeavors to preserve wildlife habitat and provide low-impact recreational access to the public. Past grant recipients include the Trust for Public Land and the Nature Conservancy. Established in 1997, the foundation is administered through Vulcan Northwest Inc. of Seattle.

To contact The Paul G. Allen Forest Protection Foundation, call Jason J. Hunke at 206.342.2000 or e-mail to: jasonh@vnw.com

American Land Conservancy Partnerships

Thanks to our Partners

The American Land Conservancy recognizes the following foundations, organizations and agencies as critical partners in our success. From providing funding to lending technical expertise, these organizations are dedicated to conserving land for the public's trust. By working in partnership, we leverage our combined experience, knowledge and financial capabilities to preserve undeveloped land for future generations.

California Rangeland Trust

California State Parks

Coastal Conservancy

County of Los Angeles Department of Parks & Recreation

The David & Lucile Packard Foundation

Friends of the Desert Mountains

Mid-State Bank

National Fish and Wildlife Foundation

THE PAUL G. ALLEN FOREST PROTECTION FOUNDATION

WCB State of California Wildlife Conservation Board

Wells Fargo

Wildlands, Inc.

Harmony Coast

San Luis Obispo County, California

By Beth Van Valkenburgh

Harmony Coast, CA (Photo by Glen Williams)

Consisting of approximately 18 miles of largely undeveloped rocky shoreline and coastal terrace, the Harmony Coast constitutes a significant segment of the evolving California Coastal Trail System. Unfortunately, due to its gently rolling hills and spectacular ocean views, the Harmony Coast is in increasing jeopardy of becoming a site for "trophy home" developments.

Presently, an opportunity exists to link protected lands along the Harmony Coast, securing the integrity of a landscape that has considerable ecological value. Recognizing the urgent need for immediate action, ALC is working with landowners, funding agencies, private donors and other partners in conservation to protect this virtually pristine stretch of California coastline from future development.

The area comprises emergent wetland habitat that provides critical nesting areas for migratory waterfowl, and is home to several listed endangered species including the California red-legged frog, Southwestern pond turtle and the White-tailed kite. It also contains some of the largest remaining stands of native coastal prairie, which once covered 20% of the State.

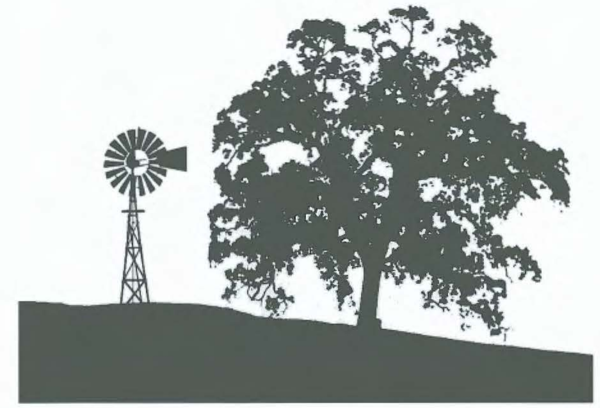
The popularity of outdoor recreation in the area, particularly shoreline-related activities, has created a need for more public access to the coast. Linking the protected lands and increasing the number of access areas for recreation along the Harmony Coast will also help avoid stress and degradation at the currently limited number of coastal access areas. ✸

The American Land Conservancy®

1388 Sutter Street, Suite 810
San Francisco, CA 94109-5453
TEL: 415-749-3010; FAX: 415-749-3011
e-mail: mail@alcnet.org

Visit us online at: www.alcnet.org

This newsletter is published by American Land Conservancy (ALC). Donations are tax-deductible to the fullest extent allowed by law.

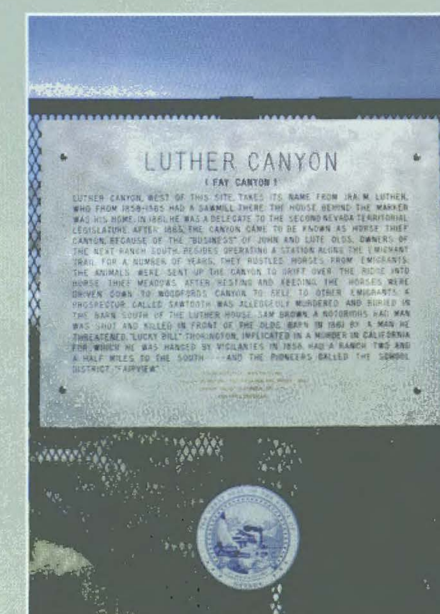


THE AMERICAN LAND CONSERVANCY *(ALC) is a private, nonprofit organization dedicated to the preservation of land and water as enduring public resources, and to the protection and enhancement of our nation's natural, ecological, historical, recreational, and scenic heritages. ALC is committed to promoting a national land ethic to achieve responsible stewardship of our public land and water for the benefit of present and future generations.*

ALC was founded 11 years ago to fill a niche in the land preservation movement. This niche consists of protecting wild places threatened by development or human encroachment too large for purchase by local land trusts and too complicated and high-risk to qualify for purchase by larger, national land trusts. ALC was formed as a national land trust specializing in complex land transactions. Since 1990, ALC has conveyed into the public trust more than 125,000 acres with a fair market value of more than $260,000,000.

Faye-Luther Trailhead Update

On June 2, 2001, members and guests of the Carson Valley Trails Association came together for a barbecue to celebrate the opening of the new Faye-Luther Trailhead and parking lot, the only legal trail access on the eastern side of the Sierras. Purchased by ALC with the assistance of the Carson Valley Trails Association, and subsequently conveyed to the National Forest Service, the property was one of the last undeveloped plots with access to Toiyabe National Forest and Jobs Peak, which overlooks South Lake Tahoe. ✸



Nevada Historical Marker 118
(American Land Conservancy Photo)

AMERICAN LAND CONSERVANCY®

Rancho Ventana

(continued from page 8)

were Senator Bruce McPherson; Senator Henry J. Mello; Executive Officer LAFCO, Nicholas Chuilos; Speaker pro Tem of the Assembly, Fred Keeley; Director of California Department of Parks and Recreation, Rusty Areias; Congressman Sam Farr's staff and Big Sur legend Billy Post. A photograph of Big Sur, by J.T. Ravize, was presented to Paul Hudson, President and CEO of Broadway Federal Bank, who provided ALC with bridge-financing for the Rancho Ventana acquisition.

Previously, ALC conveyed Limekiln Canyon, in southern Big Sur, to the California State Parks, adding coast redwood forests in rugged canyons to the State Park system. Limekiln State Park provides access from Highway 1 to Cone Peak and the high country of Los Padres National Forest, as well as to historic limekilns, waterfalls, camping, hiking trails and oceanfront beaches.

Limekiln Canyon, Big Sur, CA
(photo by Kaija Jones)

THE AMERICAN LAND CONSERVANCY
1388 SUTTER STREET, SUITE 810
SAN FRANCISCO, CA 94109

FY02 Work Plan

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

MEMORANDUM

TO: Trustee Council

FROM: Molly McCammon
Executive Director

RE: FY 02 Work Plan: Executive Director's Recommendation

DATE: July 30, 2001

Please find attached the following materials on the FY 02 work plan:

Numbers Spreadsheet (Spreadsheet A)
This spreadsheet contains, in summary form, my recommendation on all projects submitted for funding in FY 02. The spreadsheet is arranged in clusters of like projects. Cluster assignments are based on the underlying objective for each project or the type of activity the project would perform (for example, Spill Recovery Monitoring, Ecosystem Recovery and Function, GEM Transition: Tools to Improve Monitoring, etc.)

Total Fund/Fund Contingent	$ 3,113,600	(44 projects)
Total Deferred	2,036,500	(18 projects)
	$ 5,150,100	(62 projects)

The deferred list contains projects for which a recommendation is not yet being made because more information or further review is necessary, as well as projects which are considered lower priority for funding in FY 02. I would propose that, as in past years, deferred projects be taken up at a Council meeting in December. In order to meet the $5 million funding cap for FY 02, some deferred projects will likely not be funded.

The final page of the spreadsheet contains my recommendation on three projects that would be funded outside of the regular FY 02 work plan of research, monitoring, and general restoration projects. The total of these projects is $1,690,900.

Text Spreadsheet (Spreadsheet B)
This spreadsheet contains the complete text of the Chief Scientist's recommendation and my recommendation for each project submitted for funding in FY 02, as well as an abstract of each project. This spreadsheet is also arranged by cluster (a table of contents of the clusters is included, as is a numeric index that shows to which cluster each project has been assigned).

Other

The following materials are also included:

- a list of projects recommended to be deferred
- a list of new projects recommended for funding
- a summary of the Alaska SeaLife Center bench fees
- a summary of the public comment received on the Draft Work Plan
- the administration/operations budget (Project 02100)

SPRE HEET A: EXECUTIVE DIRECTOR'S RECOMMEND N / FY 02 WORK PLAN

Proj. No.	Project Title	FY 02 Revised Request	Recommendation FY 02	FY 03	Sum FY 02-03	
Oil Injury		**$953.1**	$707.7	$36.0	$743.7	
02190	Linkage Map for the Pink Salmon Genome	**$168.0**	$168.0		$168.0	Fund / Defer
02476	Effects of Oiled Incubation on Salmon Reproduction	**$39.8**	$39.8	$36.0	$75.8	Fund contingent
02486-BAA	Links: Persistent Oil in Mussel Beds & Predators	**$170.8**	$0.0	$0.0	$0.0	Do not fund
02492	Were Pink Salmon Embryo Studies Biased?	**$24.0**	$24.0	$0.0	$24.0	Fund
02538	Methods to Discriminate Herring Stocks	**$80.4**	$80.4	$0.0	$80.4	Fund contin / Defer
02543	Oil Remaining in the Intertidal	**$113.1**	$363.1		$363.1	Fund contin / Defer
02593	River Otter Synthesis	**$32.4**	$32.4	$0.0	$32.4	Fund
02639	Testing Spill Impact Hypotheses	**$71.5**	$0.0	$0.0	$0.0	Do not fund
02657	Genomic Stress Response in Sea Otters	**$43.5**	$0.0	$0.0	$0.0	Do not fund
02663	Watchdog Tool for Monitoring	**$180.9**	$0.0	$0.0	$0.0	Do not fund
02673	Continuing Decline of Pigeon Guillemots	**$28.7**	$0.0	$0.0	$0.0	Do not fund
Spill Recovery Monitoring		**$846.4**	$660.4	$0.0	$660.4	
02012-BAA	Killer Whale Investigation	**$35.2**	$35.2	$0.0	$35.2	Fund contingent
02144	Common Murre Population Monitoring	**$14.8**	$14.8	$0.0	$14.8	Fund
02159	Seabird Boat Surveys	**$194.1**	$194.1		$194.1	Defer; lower priority
02245	Community-Based Harbor Seal Biosampling	**$26.8**	$26.8	$0.0	$26.8	Fund contingent
02333	Sea Otter Monitoring	**$100.0**	$0.0	$0.0	$0.0	Do not fund
02407	Harlequin Duck Population Dynamics	**$68.7**	$68.7	$0.0	$68.7	Fund contingent
02441	Harbor Seal Diet: Lipid Metabolism & Health	**$20.2**	$20.2	$0.0	$20.2	Fund
02457-BAA	Monitoring Fall-Winter Herring Biomass	**$86.0**	$0.0	$0.0	$0.0	Do not fund
02462-CLO	Effects of Disease on Herring Recovery	**$77.4**	$77.4	$0.0	$77.4	Fund
02558	Harbor Seals: New Technologies for Monitoring Recovery	**$128.4**	$128.4		$128.4	Fund

SPREADSHEET A: EXECUTIVE DIRECTOR'S RECOMMENDATION / FY 02 WORK PLAN

Proj. No.	Project Title	FY 02 Revised Request	Recommendation FY 02	FY 03	Sum FY 02-03	
02574-BAA	Bivalve Recovery on Treated Beaches	**$94.8**	$94.8		$94.8	Defer
Ecosystem Recovery & Function		**$1,201.3**	$544.9	$189.0	$733.9	
02163-BAA	Alaska Predator Ecosystem Experiment (APEX)	**$31.1**	$0.0	$0.0	$0.0	Do not fund
02163M	APEX: Additional Manuscripts	**$50.0**	$50.0	$0.0	$50.0	Fund contingent
02195	Pristane Monitoring in Mussels	**$20.0**	$20.0	$0.0	$20.0	Fund contingent
02320	SEA: Printing Final Report	**$6.2**	$6.2	$0.0	$6.2	Defer
02372	Steller Sea Lion Monitoring	**$250.0**	$0.0	$0.0	$0.0	Do not fund
02396	Shark Assessment	**$28.8**	$28.8	$0.0	$28.8	Fund
02401	Spot Shrimp Population	**$25.5**	$25.5	$0.0	$25.5	Fund
02423	Population Change in Nearshore Vertebrate Predators	**$329.7**	$329.7	$189.0	$518.7	Fund
02452-BAA	Prey and Predators of Pink Salmon Fry	**$38.9**	$0.0	$0.0	$0.0	Do not fund
02479	Seabirds: Food Stress & Survival/Reproduction	**$55.0**	$55.0	$0.0	$55.0	Fund contingent
02503	Orca Inlet Restoration	**$100.0**	$0.0	$0.0	$0.0	Do not fund
02546	Harbor Seals: Metabolic Responses	**$50.4**	$0.0	$0.0	$0.0	Do not fund
02617	Standing Stock and Zooplankton Production	**$86.0**	$0.0	$0.0	$0.0	Do not fund
02659-BAA	Manuscripts: SEA & NVP Avian Predation	**$29.7**	$29.7	$0.0	$29.7	Defer
02669	Hooligan Research	**$100.0**	$0.0	$0.0	$0.0	Do not fund
Spill General Restoration		**$520.5**	$46.3	$0.0	$46.3	
02247	Kametolook River Coho Salmon	**$30.8**	$30.8	$0.0	$30.8	Fund
02256B-CLO	Solf Lake Sockeye Salmon Stocking	**$15.5**	$15.5	$0.0	$15.5	Fund
02416	O'Brian Creek Enhancement	**$64.2**	$0.0	$0.0	$0.0	Do not fund
02507	Nuchek Subsistence Camp	**$125.0**	$0.0	$0.0	$0.0	Do not fund
02662	Restoration by Manipulation	**$103.0**	$0.0	$0.0	$0.0	Do not fund

SPREADSHEET A: EXECUTIVE DIRECTOR'S RECOMMENDATION / FY 02 WORK PLAN

Proj. No.	Project Title	FY 02 Revised Request	Recommendation FY 02	FY 03	Sum FY 02-03	
02677	English Bay Sockeye Enumeration	**$182.0**	$0.0	$0.0	$0.0	Do not fund
GEM Transition: Strategies to Improve Monitoring		**$799.2**	$200.8	$0.0	$200.8	
02395	Nearshore/Intertidal Monitoring Workshop	**$63.6**	$63.6	$0.0	$63.6	Fund contingent
02532	Coupling of Oceanic & Nearshore	**$121.3**	$0.0	$0.0	$0.0	Do not fund
02556	Mapping Marine Habitats	**$50.0**	$50.0	$0.0	$50.0	Defer
02565	Controlling Forces in Kachemak Bay	**$49.9**	$0.0	$0.0	$0.0	Do not fund
02569	Monitoring Workshop	**$15.3**	$0.0	$0.0	$0.0	Do not fund
02601-BAA	Methodological Data Gaps	**$189.5**	$0.0	$0.0	$0.0	Do not fund
02604	Gear Selectivity in Trawl Surveys	**$52.1**	$0.0	$0.0	$0.0	Do not fund
02612	Marine-Terrestial Linkages in Kenai River Watershed	**$44.6**	$44.6	$0.0	$44.6	Fund
02644	Molecular Biomarker Technique for Assessing Stress	**$114.1**	$0.0	$0.0	$0.0	Do not fund
02648-BAA	Adaptive Sampling	**$56.2**	$0.0	$0.0	$0.0	Do not fund
02674-BAA	Pigeon Guillemot Restoration Techniques	**$42.6**	$42.6		$42.6	Fund
GEM Transition: Tools to Improve Monitoring		**$745.9**	$386.0	$17.1	$403.1	
02404	Testing Archival Tag Technology in Alaska Salmon	**$104.6**	$104.6	$0.0	$104.6	Fund contingent
02434	Seabird Monitoring: East Amatuli Island Video	**$4.3**	$0.0	$0.0	$0.0	Do not fund
02584	Airborne Remote Sensing Tools	**$118.4**	$75.0		$75.0	Defer
02614	Monitoring Temperature, Salinity, and Fluorescence	**$38.2**	$38.2	$17.1	$55.3	Fund contingent
02618-BAA	Tide Rip Front Variability	**$11.7**	$0.0	$0.0	$0.0	Do not fund
02624-BAA	Ships of Opportunity: CPR-Based Plankton Survey	**$133.4**	$133.4	$0.0	$133.4	Defer
02627-BAA	Symbiotic Acoustic Signal Processor	**$171.0**	$0.0	$0.0	$0.0	Do not fund
02640	High Frequency Surface Wave Radar Test	**$129.5**	$0.0	$0.0	$0.0	Do not fund
02671-BAA	Ships of Opportunity: Kachemak Bay & Lower Cook Inlet	**$34.8**	$34.8	$0.0	$34.8	Fund

SPREADSHEET A: EXECUTIVE DIRECTOR'S RECOMMENDATION / FY 02 WORK PLAN

Proj. No.	Project Title	FY 02 Revised Request	Recommendation FY 02	FY 03	Sum FY 02-03	
GEM Transition: Synthesis & Retrospective Analysis		**$1,100.6**	$471.2	$46.2	$517.4	
02578	Macrofauna Annotated List	**$38.3**	$35.0	$0.0	$35.0	Defer; lower priority
02597-BAA	Ocean Color Time Series of PWS	**$28.5**	$0.0	$0.0	$0.0	Do not fund
02600	EVOS Synthesis, 1989-2001	**$151.6**	$151.6		$151.6	Defer
02622	Digital ESI Maps: Cook Inlet/Kenai Peninsula	**$36.6**	$36.6	$0.0	$36.6	Defer; lower priority
02636-BAA	Ecosystem Recovery: Spill-Impacted Communities	**$360.0**	$50.0		$50.0	Defer
02649	Reconstructing Sockeye Populations	**$88.1**	$88.1	$28.2	$116.3	Fund contingent
02656	Nearshore Analysis: Archaeology & Isotopes	**$109.9**	$109.9	$18.0	$127.9	Fund
02664	Retrospective Analysis of Seabird Data	**$287.6**	$0.0	$0.0	$0.0	Do not fund
GEM Transition: Long-Term Monitoring		**$1,619.5**	$666.1	$11.6	$677.7	
02210	PWS/LCI Youth Area Watch	**$106.1**	$106.1		$106.1	Fund
02340	Long-Term Oceanographic Monitoring (GAK 1)	**$77.8**	$77.8		$77.8	Fund contingent
02552-BAA	Exchange Between PWS and GOA	**$102.5**	$102.5	$0.0	$102.5	Defer
02561	Community-Based Forage Fish Sampling	**$54.3**	$54.3	$11.6	$65.9	Fund
02589-BAA	PWSRCAC Long-Term Monitoring	**$233.3**	$0.0	$0.0	$0.0	Do not fund
02603	Ocean Circulation Model	**$73.2**	$66.4	$0.0	$66.4	Defer
02609	Long-Term Temperature/Salinity Monitoring	**$59.8**	$0.0	$0.0	$0.0	Do not fund
02610	Kodiak Island Youth Area Watch	**$61.8**	$61.8		$61.8	Fund
02628-BAA	Resurrection Bay Contaminant Survey	**$128.8**	$0.0	$0.0	$0.0	Do not fund
02633	Kodiak Region Water Quality	**$446.6**	$0.0	$0.0	$0.0	Do not fund
02634	STAMP	**$54.9**	$54.9	$0.0	$54.9	Defer; lower priority
02667	Effectiveness of Citizens' Environmental Monitoring	**$16.7**	$16.7	$0.0	$16.7	Fund
02678-BAA	Use of Commercial Fisheries Bycatch for Scientific Gain	**$128.1**	$0.0	$0.0	$0.0	Do not fund

Proj. No.	Project Title	FY 02 Revised Request	Recommendation FY 02	FY 03	Sum FY 02-03	
02680	Persistent Organic Contaminants in Alaska Fishes	**$75.6**	$75.6	$0.0	$75.6	Defer
02681	Placeholder: Nearshore/Intertidal Monitoring		$50.0		$50.0	Defer
Habitat Protection & Improvements		**$141.0**	$141.0	$0.0	$141.0	
02621	Kenai River Flats Conservation Easement	**$141.0**	$141.0	$0.0	$141.0	Defer
Data Management & Information Transfer		**$994.2**	$217.7	$0.0	$217.7	
02290	Hydrocarbon Database	**$35.0**	$35.0		$35.0	Fund contingent
02455	GEM Data System	**$105.0**	$105.0		$105.0	Fund contingent
02475-BAA	GEM Data System Specification	**$250.9**	$0.0	$0.0	$0.0	Do not fund
02536	Heritage Data Management System	**$118.2**	$0.0	$0.0	$0.0	Do not fund
02608	Archiving of Nearshore & Deep Benthic Specimens	**$61.6**	$61.6	$0.0	$61.6	Fund
02637	Early Life History Database	**$143.7**	$0.0	$0.0	$0.0	Do not fund
02643	Environmental Specimen Bank Program for GEM	**$85.4**	$0.0	$0.0	$0.0	Do not fund
02646-BAA	Interactive Database on Alaskan Seaweeds	**$58.0**	$0.0	$0.0	$0.0	Do not fund
02655-BAA	Transition Support for the GEM Data Manager	**$120.3**	$0.0	$0.0	$0.0	Do not fund
02668	Interactive Water Quality and Habitat Database	**$16.1**	$16.1	$0.0	$16.1	Defer
Community Involvement/Public Outreach/Other		**$1,424.8**	$1,108.0	$0.0	$1,108.0	
02052	Community Involvement	**$214.2**	$180.0		$180.0	Fund contin / Defer
02250	Project Management	**$271.4**	$181.7		$181.7	Fund
02350	ASLC Bench Fees	**$310.4**	$310.4		$310.4	Fund
02360-BAA	Guidance for Future Research Activities	**$90.1**	$90.1	$0.0	$90.1	Fund
02535	EVOS Trustee Council Final Report	**$52.4**	$52.4	$0.0	$52.4	Fund
02550	ARLIS	**$144.3**	$93.4		$93.4	Fund
02570	Book on EVOS Science for General Readers	**$47.0**	$0.0	$0.0	$0.0	Do not fund

Proj. No.	Project Title	FY 02 Revised Request	Recommendation FY 02	FY 03	Sum FY 02-03	
02629-BAA	Paradigm for Ecosystem Monitoring	**$95.0**	$0.0	$0.0	$0.0	Do not fund
02630	Planning for GEM	**$200.0**	$200.0		$200.0	Fund / Defer
	Total:	**$10,346.5**	$5,150.1	$299.9	$5,450.0	

SPRE HEET A: EXECUTIVE DIRECTOR'S RECOMMEND N / PROJECTS OUTSIDE FY 02 WORK PLAN

Proj. No.	Project Title	FY 02 Revised Request	Recommendation FY 02	Recommendation FY 03	Recommendation Sum FY02-03	Recommendation
Spill General Restoration		**$29.1**	$29.1		$29.1	
02154	Archaeological Repository Support Costs	**$29.1**	$29.1		$29.1	Fund OUTSIDE
Habitat Protection & Improvements		**$161.8**	$161.8		$161.8	
02126	Habitat Protection Support	**$161.8**	$161.8		$161.8	Fund OUTSIDE
Public Information/Science Management/Administration		**$1,500.0**	$1,500.0		$1,500.0	
02100	Public Info./Science Mgt./Admin.	**$1,500.0**	$1,500.0		$1,500.0	Fund OUTSIDE
	Total:	**$1,690.9**	$1,690.9		$1,690.9	

Executive Director's Recommendation

FY 02 Work Plan / August 2001

Table of Contents: Spreadsheet B

FY 02 WORK PLAN uster Reference Sheet

Proj.No.	Project Title	Cluster Assignment
02012-BAA	Photographic and Acoustic Monitoring of Killer Whales in Prince William Sound and Kenai Fjords	Spill Recovery Monitoring
02052	Community Involvement/Planning for GEM	Community Involvement/Public Outreach/Other
02100	Public Information, Science Management, and Administration	Community Involvement/Public Outreach/Other
02126	Habitat Protection and Acquisition Support	Habitat Protection & Improvements
02144	Common Murre Population Monitoring	Spill Recovery Monitoring
02154	Archaeological Repository, Display Facilities, and Exhibits for Prince William Sound and Lower Cook Inlet	Spill General Restoration
02159	Surveys to Monitor Marine Bird Abundance in Prince William Sound During Winter and Summer 2002	Spill Recovery Monitoring
02163-BAA	Alaska Predator Ecosystem Experiment in Prince William Sound and the Gulf of Alaska (APEX)	Ecosystem Recovery & Function
02163M	APEX: Numerical and Functional Response of Seabirds to Fluctuations in Forage Fish Density	Ecosystem Recovery & Function
02190	Construction of a Linkage Map for the Pink Salmon Genome	Oil Injury
02195	Pristane Monitoring in Mussels	Ecosystem Recovery & Function
02210	Prince William Sound/Lower Cook Inlet Youth Area Watch	GEM Transition: Long-Term Monitoring
02245	Community-Based Harbor Seal Management and Biological Sampling	Spill Recovery Monitoring
02247	Kametolook River Coho Salmon Subsistence Project	Spill General Restoration
02250	Project Management	Community Involvement/Public Outreach/Other
02256B-CLO	Sockeye Salmon Stocking at Solf Lake	Spill General Restoration
02290	Hydrocarbon Database and Interpretation Service	Data Management & Information Transfer
02320	Sound Ecosystem Assessment (SEA): Printing the Final Report	Ecosystem Recovery & Function
02333	Sea Otter Monitoring	Spill Recovery Monitoring
02340	Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem	GEM Transition: Long-Term Monitoring
02350	Alaska SeaLife Center Bench Fees	Community Involvement/Public Outreach/Other
02360-BAA	The *Exxon Valdez* Oil Spill: Guidance for Future Research Activities	Community Involvement/Public Outreach/Other
02372	Steller Sea Lion Monitoring	Ecosystem Recovery & Function
02395	Workshop on Nearshore/Intertidal Monitoring	GEM Transition: Strategies to Improve Monitoring
02396	Alaska Salmon Shark Assessment	Ecosystem Recovery & Function
02401	Assessment of Spot Shrimp Abundance in Prince William Sound	Ecosystem Recovery & Function

FY 02 WORK PLAN uster Reference Sheet

Proj.No.	Project Title	Cluster Assignment
02404	Testing Archival Tag Technology in Coho Salmon	GEM Transition: Tools to Improve Monitoring
02407	Harlequin Duck Population Dynamics	Spill Recovery Monitoring
02416	O'Brian Creek Enhancement	Spill General Restoration
02423	Patterns and Processes of Population Change in Selected Nearshore Vertebrate Predators	Ecosystem Recovery & Function
02434	Design of a Video System for Remotely Monitoring Seabirds at East Amatuli Island	GEM Transition: Tools to Improve Monitoring
02441	Harbor Seal Recovery: Effects of Diet on Lipid Metabolism and Health	Spill Recovery Monitoring
02452-BAA	Assessing Prey and Competitor/Predators of Pink Salmon Fry	Ecosystem Recovery & Function
02455	GEM Data System	Data Management & Information Transfer
02457-BAA	Monitoring the Fall-Winter Herring Biomass to Track the Recovery of the Prince William Sound Herring Stock	Spill Recovery Monitoring
02462-CLO	Effects of Disease on Pacific Herring Population Recovery in Prince William Sound	Spill Recovery Monitoring
02475-BAA	GEM Data System Specification	Data Management & Information Transfer
02476	Effects of Oiled Incubation Substrate on Pink Salmon Reproduction	Oil Injury
02479	Effects of Food Stress on Survival and Reproductive Performance of Seabirds	Ecosystem Recovery & Function
02486-BAA	Links Between Persistent Oil in Mussel Beds and Predators	Oil Injury
02492	Were Pink Salmon Embryo Studies in Prince William Sound Biased?	Oil Injury
02503	Orca Inlet Restoration	Ecosystem Recovery & Function
02507	Nuchek Subsistence Camp	Spill General Restoration
02532	Coupling of Oceanic and Nearshore: The Search for Indicator Species	GEM Transition: Strategies to Improve Monitoring
02535	EVOS Trustee Council Restoration Program Final Report	Community Involvement/Public Outreach/Other
02536	Synthesis of Spill Damaged Resource Information into the Heritage Data Management System	Data Management & Information Transfer
02538	Evaluation of Two Methods to Discriminate Pacific Herring Stocks along the Northern Gulf of Alaska	Oil Injury
02543	Evaluation of Oil Remaining in the Intertidal from the *Exxon Valdez* Oil Spill	Oil Injury
02546	Assessing Harbor Seals: Methods to Identify Metabolic Responses to Environmental Change	Ecosystem Recovery & Function
02550	Alaska Resources Library and Information Services (ARLIS)	Community Involvement/Public Outreach/Other
02552-BAA	Exchange Between Prince William Sound and the Gulf of Alaska	GEM Transition: Long-Term Monitoring
02556	Mapping Marine Habitats: The First Step in a Spatially Nested Monitoring Program	GEM Transition: Strategies to Improve Monitoring

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Proj.No.	Project Title	Cluster Assignment
02558	Harbor Seal Recovery: Application of New Technologies for Monitoring Health	Spill Recovery Monitoring
02561	Evaluating the Feasibility of Developing a Community- Based Forage Fish Sampling Project for GEM	GEM Transition: Long-Term Monitoring
02565	Bottom-Up vs. Top Down: What Forces Control Variability in Kachemak Bay?	GEM Transition: Strategies to Improve Monitoring
02569	Linked Monitoring Network for the Gulf of Alaska: A Workshop	GEM Transition: Strategies to Improve Monitoring
02570	Book on EVOS Science for General Readers	Community Involvement/Public Outreach/Other
02574-BAA	Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound	Spill Recovery Monitoring
02578	The Marine Macrofauna of Prince William Sound: An Annotated List	GEM Transition: Synthesis & Retrospective Analysis
02584	Evaluation of Airborne Remote Sensing Tools for GEM Monitoring	GEM Transition: Tools to Improve Monitoring
02589-BAA	PWSRCAC - EVOS Long Term Environmental Monitoring Program	GEM Transition: Long-Term Monitoring
02593	River Otters and Fishes in the Nearshore Environment: A Synthesis	Oil Injury
02597-BAA	Ocean Color Time Series of Prince William Sound	GEM Transition: Synthesis & Retrospective Analysis
02600	Synthesis of the Ecological Findings from the EVOS Damage Assessment and Restoration Programs, 1989-2001	GEM Transition: Synthesis & Retrospective Analysis
02601-BAA	GEM Transition: Addressing Methodological Data Gaps	GEM Transition: Strategies to Improve Monitoring
02603	Implementation of an Ocean Circulation Model: A Transition from SEA to GEM	GEM Transition: Long-Term Monitoring
02604	Gear Selectivity in Trawl Surveys along the Northern Gulf of Alaska	GEM Transition: Strategies to Improve Monitoring
02608	Permanent Archiving of Specimens Collected in Nearshore Habitats	Data Management & Information Transfer
02609	Long-Term Temperature/Salinity Monitoring Within the Alaska Coastal Current	GEM Transition: Long-Term Monitoring
02610	Kodiak Archipelago Youth Area Watch	GEM Transition: Long-Term Monitoring
02612	Detecting and Understanding Marine-Terrestrial Linkages in the Kenai River Watershed	GEM Transition: Strategies to Improve Monitoring
02614	Monitoring Program for Near-Surface Temperature, Salinity, and Fluorescence in the Northern Pacific Ocean	GEM Transition: Tools to Improve Monitoring
02617	Standing Stock and Secondary Production of Zooplankton in Prince William Sound	Ecosystem Recovery & Function
02618-BAA	Measurements of Tide Rip Front Variability in Cook Inlet	GEM Transition: Tools to Improve Monitoring
02621	Kenai River Flats Conservation Easement and Public Education	Habitat Protection & Improvements
02622	Digital Maps from Existing Seasonal Environmental Sensitive Area Maps: Cook Inlet/ Kenai Peninsula	GEM Transition: Synthesis & Retrospective Analysis
02624-BAA	A CPR-Based Plankton Survey Using Ships of Opportunity to Monitor the Gulf of Alaska	GEM Transition: Tools to Improve Monitoring

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Proj.No.	Project Title	Cluster Assignment
02627-BAA	A Symbiotic Acoustic Signal Processor to Increase Stock Assessment Effort	GEM Transition: Tools to Improve Monitoring
02628-BAA	Resurrection Bay Contaminant Survey	GEM Transition: Long-Term Monitoring
02629-BAA	Development of a Paradigm for Ecosystem Monitoring	Community Involvement/Public Outreach/Other
02630	Planning for Long-Term Monitoring and Research Program	Community Involvement/Public Outreach/Other
02633	Acquisition of Chemical, Physical, and Biological Information on Kodiak Regional Water Quality	GEM Transition: Long-Term Monitoring
02634	Expanding the Seabird Tissue Archival and Monitoring Project (STAMP) Program for GEM	GEM Transition: Long-Term Monitoring
02636-BAA	Ecosystem Recovery Through a Partnership with the Spill-Impacted Communities	GEM Transition: Synthesis & Retrospective Analysis
02637	Online Early Life History Database for the Northeast Pacific Ocean, Gulf of Alaska and Southeast Bering Sea	Data Management & Information Transfer
02639	Field Experiments for Testing Spill-Impacts Hypotheses from Long-Term Monitoring	Oil Injury
02640	High Frequency Surface Wave Radar Test in Prince William Sound	GEM Transition: Tools to Improve Monitoring
02643	Design of the Environmental Specimen Bank Program for GEM	Data Management & Information Transfer
02644	Molecular Biomarkers as a New Technique for Assessing Physiological Contaminant Stress	GEM Transition: Strategies to Improve Monitoring
02646-BAA	Information Dissemination through the Web: Developing an Interactive Database on Southcentral Alaskan Seaweeds	Data Management & Information Transfer
02648-BAA	Cost Effective Data Acquisition Using Adaptive Sampling and Combining Information Strategies	GEM Transition: Strategies to Improve Monitoring
02649	Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years	GEM Transition: Synthesis & Retrospective Analysis
02655-BAA	Transition Support for the GEM Data Manager	Data Management & Information Transfer
02656	Retrospective Analysis of Nearshore Marine Communities Based on Analysis of Archaeological Material and Isotopes	GEM Transition: Synthesis & Retrospective Analysis
02657	Analysis of Genomic Stress Response in Sea Otters	Oil Injury
02659-BAA	Preparation and Publication of Results from SEA and NVP Avian Predation Studies	Ecosystem Recovery & Function
02662	Natural Life Restoration by Manipulation	Spill General Restoration
02663	"Watchdog Tool" for Sampling and Monitoring	Oil Injury
02664	Retrospective Analysis of 30 Years of Seabird Distribution and Diet Data	GEM Transition: Synthesis & Retrospective Analysis
02667	Effectiveness of Citizens' Environmental Monitoring Program	GEM Transition: Long-Term Monitoring
02668	Developing an Interactive Water Quality and Habitat Database and Making it Accessible on the Web	Data Management & Information Transfer

FY 02 WORK PLAN uster Reference Sheet

Proj.No.	Project Title	Cluster Assignment
02669	Hooligan Research	Ecosystem Recovery & Function
02671-BAA	Coordinating Volunteer Vessels of Opportunity to Collect Oceanographic Data in Kachemak Bay and Lower Cook Inlet	GEM Transition: Tools to Improve Monitoring
02673	Continuing Decline of Pigeon Guillemots in the Oiled Portion of Prince William Sound	Oil Injury
02674-BAA	Assessing Pigeon Guillemot Restoration Techniques	GEM Transition: Strategies to Improve Monitoring
02677	English Bay River Sockeye Salmon Enumeration Project	Spill General Restoration
02678-BAA	Identifying Community-Based Ways to Use Commercial Fisheries Bycatch for Scientific Gain	GEM Transition: Long-Term Monitoring
02680	Remote Delivery of Persistent Organic Contaminants in Alaska Fishes	GEM Transition: Long-Term Monitoring
02681	Placeholder: Nearshore/Intertidal Monitoring	GEM Transition: Long-Term Monitoring

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
Oil Injury					$953.1	$707.7	$299.7	$36.0
02190	Construction of a Linkage Map for the Pink Salmon Genome	F. Allendorf/Univ. Montana	ADFG	Cont'd 7th yr. 8 yr. project	$168.0	$168.0	$80.3	

Project Abstract

This project will complete the analysis of experiments conducted at the Alaska SeaLife Center that use the linkage map to test for effects of regions of the genome on traits that are important to recovery of pink salmon (e.g., growth and survival). Sexually mature adults from the 1999 cohorts produced from wild pink salmon collected from Likes Creek are expected to return to Resurrection Bay in August and September 2001. Genotypes in released fry will be compared to returning adults to test for genetic differences in marine survival and other life history traits (e.g., body size, egg number, and egg size). [Note: This project, which was scheduled to close out in FY 02, is now requesting $80,300 for FY 03.]

Chief Scientist's Recommendation

This project has already produced a linkage map including a large number of genes in the pink salmon genome. The remaining objectives, determining the relationships between growth and survival and mapped genes, depend entirely on the success of the project in capturing experimental fish released in 2000 from the Alaska SeaLife Center and returning to upper Resurrection Bay in 2001. At least 200 fish need to be captured to draw conclusions about the relationships. Defer funding pending evaluation of field collections from summer of FY 01.

Executive Director's Recommendation

Fund interim amount ($43,100); defer decision on balance of funding ($124,900) to December, pending outcome of FY 01 (Summer 2001) capture effort. If at least 200 fish are captured, the project will proceed as proposed in FY 02, with the balance of funds to be approved by the Trustee Council in December 2001 and project closeout in FY 03. If 200 or more fish are not captured, the interim funds will be used for project closeout in FY 02. This project is important for understanding the genetic traits of pink salmon that affect growth and survival. In addition, the work being done under this project will lay the foundation for experiments to answer questions important to fisheries management about hatchery/wild fish interactions. For example, are hatchery fish changing the gene pool in a way that makes wild fish maladapted to their environment? Are enough hatchery fish getting into streams to effect productivity of wild fish? How adapted are wild fish to particular streams?

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02476	Effects of Oiled Incubation Substrate on Pink Salmon Reproduction	R. Heintz/NOAA	NOAA	Cont'd 4th yr. 5 yr. project	$39.8	$39.8	$36.0	$36.0

Project Abstract

Populations are maintained through successful reproduction; this project is designed to determine if exposure to oil impairs pink salmon reproduction. Examination of the ability of the parental generation (P1) to produce offspring (F1) is underway. The P1 was exposed when they incubated in 1998; the F1 incubated in clean water beginning in FY 01. After the F1 emerges in spring 2001, the fish will be marked and released. At the end of FY 02, the released fish will be recovered when they return as mature adults. At that time, the project will measure the ability of the F1 to produce viable offspring (F2). A diminished ability to produce the F2 generation represents a genetic effect transmitted to unexposed generations. Such an effect was demonstrated in similarly treated pink salmon in 1997, but corroborating data do not exist.

Chief Scientist's Recommendation

This continuing project will test whether all of the data pointing to multi-generational effects of PAH exposure from the spill on pink salmon can be experimentally corroborated. The investigators are well qualified and experienced, and if sufficient oil-exposed fish return to Little Port Walter the project should be successful in providing valuable information for assessment of injury. Fund.

Executive Director's Recommendation

Fund contingent on submittal of overdue reports (99347, 00476). This project is validating the effects of oil contamination on pink salmon, thus contributing to our understanding of the injury and recovery status of this injured species. Project closeout is scheduled for FY 03.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02486-BAA	Links Between Persistent Oil in Mussel Beds and Predators	S. Rice/NOAA, T. Dean/Coastal Resources Associates, S. Jewett/UAF	NOAA	New 1st yr. 2 yr. project	$170.8	$0.0	$130.0	$0.0

Project Abstract

Links between oil-contaminated mussel beds and impacts on infauna and vertebrate predators have been inferred, but have not been definitively demonstrated. Significant oil concentrations in some mussel beds have persisted to present, much longer that originally expected, and may explain contemporary observations of vertebrate predator exposure to oil. The possibility that oiled beds are long-term sources of vertebrate contamination was unanticipated, and has implications for future monitoring and response decisions in the event of future spills. In a more holistic approach than in the past, this project will examine evidence for links between persistence of *Exxon Valdez* oil in mussel beds, infauna, and in nearshore vertebrate predators.

Chief Scientist's Recommendation

This project would further investigate the implications of remaining oil in the Prince William Sound intertidal zone, much of which can still be found at relatively high concentrations in mussel beds. The proposal does not present a compelling argument for how the results from small areas can be interpreted on the scale of the entire sound. For example, how much feeding do harlequin ducks, sea otters, and Barrow's goldeneyes do in oiled mussel beds as opposed to outside them? Can we compare the amounts of oil remaining in mussel beds with those in other intertidal and subtidal areas? These questions are hard to answer, but without answering them the results of this project cannot be effectively tied to evidence of continued oil exposure. Given the cost of this proposal, the uncertainties in interpretation, and the need to commit funds into FY 03, this is a lower priority. Do not fund.

Executive Director's Recommendation

Do not fund. This project would study possible links between oiled mussel beds and predators which were not anticipated, have not been studied directly, and may explain ongoing observations of vertebrate predator exposure to oil. However, the Chief Scientist has raised a number of technical concerns about the project, and for that reason it is a lower priority.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02492	Were Pink Salmon Embryo Studies in Prince William Sound Biased?	J. Thedinga/NOAA	NOAA	Cont'd 2nd yr. 2 yr. project	$24.0	$24.0	$0.0	$0.0

Project Abstract

Effects of the oil spill on wild pink salmon embryo survival in Prince William Sound are disputed among government- and industry-sponsored researchers. Exxon contends that the government's conclusions that reduced embryo viability in oiled streams was caused by persistent oil contamination were biased because sampling times were earlier in oiled streams than in reference streams. Experimental studies to determine the ability to discriminate eggs killed by sampling (shock mortality) and previously dead eggs were conducted to help ascertain if estimates of embryo survival in the sound were accurate or biased. Preliminary results indicate that shock resistance of eggs increased in a sigmoidal fashion from the end of September to mid-November and that the timing of egg examination after being pumped from a stream is critical in differentiating shocked eggs from previously dead eggs. By removing eggs pumped from stream gravel soon after sampling, shocked eggs were easily discernible and could easily be separated from previously dead eggs. These results suggest that further examination of procedures used for egg sampling in the sound following the oil spill would not help clarify the controversy over potential biased estimates of egg survival.

Chief Scientist's Recommendation

This study addresses some crucial questions of potential bias in evaluation of pink salmon embryo mortality in the field samples collected 1989-94. This study has apparently resolved the time course of egg opacity after shocking, and is addressing potential observer bias in evaluating embryo mortality. Publishing the results of these studies as soon as possible is crucially important to understanding injury to pink salmon. Fund closeout as proposed.

Executive Director's Recommendation

Fund closeout of this project (final report and two manuscripts). Exxon contends that the governments' conclusion that reduced embryo viability in oiled streams was caused by persistent oil contamination were biased due to sampling timing. In FY 01, the Trustee Council initiated this study to determine if estimates of pink salmon embryo survival following the oil spill were accurate. Based on the preliminary results, the claims advanced by Exxon appear to be invalid and experimental conditions do not permit further investigation. The principal investigator requested funds for closeout only.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02538	Evaluation of Two Methods to Discriminate Pacific Herring Stocks along the Northern Gulf of Alaska	T. Otis/ADFG, R. Heintz/NOAA	ADFG	Cont'd 2nd yr. 2 yr. project	$80.4	$80.4	$0.0	$0.0

Project Abstract

This project will perform a comparative investigation of two promising stock identification techniques for Pacific herring--elemental analysis of otoliths and fatty acid profile analysis of select soft tissues. Limited samples from Sitka Sound, Prince William Sound, Kamishak Bay, Kodiak Island, and Togiak will be collected and analyzed to determine if stock differences are detectable by each procedure, and at what scale. Successful results from this pilot study should be followed up with future evaluations of the temporal and structural (i.e., sex, age, maturity) stability of these biomarkers.

Chief Scientist's Recommendation

The goal of this project, to explore potential geographic composition of spawning aggregations, addresses an important question for management of herring in the oil spill area. The project is on track as reviewed in FY 01. Collections of herring in the fall should be made to obtain additional material for stock identification using the experimental techniques of this project. Investigators are encouraged to compile and use environmental data from the areas where the herring collections are being made in order to better interpret the results of the elemental analysis of otoliths. Investigators are also encouraged to at least double the amount of otoliths and heart tissue necessary to meet project-specified sampling objectives in order to archive for possible future analysis. Fund, including increment for Fall 2001 sampling.

Executive Director's Recommendation

Fund analysis of Spring 2001 samples and collection of Fall 2001 samples ($52,900) contingent on (a) submittal and approval of a revised Detailed Project Description and budget that include a new objective related to Fall 2001 sampling and (b) submittal of overdue reports (99347, 00476). Defer decision on funding analysis of Fall 2001 samples (roughly $27,500) pending review of preliminary results from analysis of Spring 2001 samples. The ability to determine the stock of origin for herring sampled during field investigations will allow increased understanding of the distribution and mixing of northwest Gulf of Alaska herring stocks and assist in the identification of important habitats and rearing areas for individual populations.

SPREADSHEET B: EXECUTIVE DIRECTOR'S RECOMMENDATION / FY 02 WORK PLAN

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02543	Evaluation of Oil Remaining in the Intertidal from the *Exxon Valdez* Oil Spill	J. Short/NOAA	NOAA	Cont'd 2nd yr. 2 yr. project	$113.1	$363.1	$0.0	

Project Abstract

This project will assess the amount of oil remaining from the oil spill on shorelines within Prince William Sound in FY 01. A stratified random sample of shoreline will be intensively sampled for surface and subsurface oil to estimate length of oiled shoreline, area and volume of oiled sediment, and volume of oil. Approximately 8 km will be sampled by digging about 8,000 pits to discover and quantify subsurface oil. In FY 02, Phase III of this project will be devoted to data and chemical analysis, preparation of a final report, and journal publications. No fieldwork is proposed for FY 02.

Chief Scientist's Recommendation

The public and the Trustee Council want to know as accurately as can be estimated the amount of oil that remains in Prince William Sound. This continuing project will provide the answer in as rigorous a manner as possible. It is also appropriate to set aside funds for possible follow-up work on residual oil in FY 02, depending on a review of the preliminary results, which are expected November 2001. Fund original request; defer decision on follow-up funding.

Executive Director's Recommendation

Fund original request ($113,100 for data and chemical analysis, final report preparation, and journal publications) contingent on submittal of overdue report (00195) and manuscript (00598). Defer decision on possible additional funding (the $250,000 shown above is a placeholder) until December, pending review of the preliminary results of the survey of remaining oil underway in Summer 2001 (preliminary results are expected early November 2001). The survey is assessing the surface area and volume of shoreline in Prince William Sound still contaminated with *Exxon Valdez* oil. The results may warrant further investigation of remaining oil or the possible effects of remaining oil on injured species, and funds are being set aside for this purpose. Additional surveys outside of Prince William Sound are not anticipated--the Council funded a final comprehensive assessment of oil around Kodiak in FY 95 and along the Kenai and Alaska peninsulas in FY 99.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02593	River Otters and Fishes in the Nearshore Environment: A Synthesis	S. Jewett/UAF	ADFG	New 1st yr. 1 yr. project	$32.4	$32.4	$23.9	$0.0

Project Abstract

This project will integrate data collected on river otters and fishes in Prince William Sound through efforts of the NVP/025 (Nearshore Vertebrate Predator), APEX/163 (Alaska Predator Ecosystem Experiment), and SEA/320 (Sound Ecosystem Assessment) projects. Social organization and population dynamics of river otters, specialized fish-predators, are dependent on abundance and availability of fishes. This project will test the dependence of sociality in river otters on the availability of schooling fishes and evaluate the relation between the spatial and temporal distribution of fishes and those of river otter groups.

Chief Scientist's Recommendation

This is an innovative and thoughtful proposal by investigators with a proven track record of studying this species and system. The proposal is well conceived and well written. This project could possibly provide an alternative explanation for phenomena previously observed and attributed to the spill, as well as make a contribution towards understanding how the environment affects behavior of river otters. Fund revised proposal, which focuses on the manuscript on river otter sociality only.

Executive Director's Recommendation

Fund revised proposal, which reduces the scope to manuscript #1 only (forage fishes and river otter sociality). This project will draw on data collected through earlier Trustee Council funded projects (025/Nearshore Vertebrate Predator, 163/Alaska Predator Ecosystem Experiment, 320/Sound Ecosystem Assessment, 348/Responses of River Otters to Oil Contamination).

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02639	Field Experiments for Testing Spill-Impacts Hypotheses from Long-Term Monitoring	G. Shigenaka/NOAA HAZMAT	NOAA	New 1st yr. 1 yr. project	$71.5	$0.0	$0.0	$0.0

Project Abstract

The National Oceanic and Atmospheric Adminstration (NOAA) initiated two intertidal experiments in 2000 to test hypotheses concerning long-term effects of oil spill cleanup. The first experiment, located in Kasitsna Bay, tests the hypothesis that aggressive shoreline cleanup has caused unnatural long-term cycling in rocky intertidal communities, *Fucus* in particular. The second experiment, in lower Herring Bay, tests the hypothesis that shoreline washing on oiled beaches physically alters grain size structure to the extent that biological recovery has been delayed and infaunal communities are fundamentally altered. Although both of these experiments were begun under NOAA's long-term monitoring program, that program has ended. This project will permit annual sampling and data collection while transitioning the Kasitsna Bay project to the Kachemak Bay National Estuarine Research Reserve and the lower Herring Bay project to alternative funding support in 2003.

Chief Scientist's Recommendation

This is an interesting and well presented proposal to monitor two field experiments to test mechanisms of injury that might explain long-term effects of the spill and cleanup on the intertidal zone. There were questions about the experimental design raised during the review with regard to spatial scale in the *Fucus* experiment and temporal scale in the response expected. The proposers did not provide evidence that the washing experiment removed fine grain sediment to the extent that mimicked the clean up operations in 1989 and 1990. Do not fund.

Executive Director's Recommendation

Do not fund. This project would continue two field experiments begun in 2000 by the National Oceanic and Atmospheric Administration's Office of Response and Restoration. The Chief Scientist has identified concerns with the project's experimental design. Furthermore, this activity is not a priority at this stage of the restoration program as the Trustee Council's focus shifts to GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02657	Analysis of Genomic Stress Response in Sea Otters	C. Mohr, J. Stott/UC Davis, B. Ballachey/USGS	DOI	New 1st yr. 1 yr. project	$43.5	$0.0	$0.0	$0.0

Project Abstract

In summer 2001, as part of Project 01423, sea otters will be captured in oiled and unoiled areas of Prince William Sound for assessment of CYP1A levels. This project will complement Project 01423 by applying novel, highly sensitive molecular techniques for the measurement of health status, toxicant exposure, and metabolic processes in the sea otter. The project will characterize and compare the genomic stress response in peripheral blood mononuclear cells by examining the differential expression of a suite of key genes that are indicators of immunological, cellular, and metabolic responses to stress. The results of the study will enhance understanding of the status of recovery of sea otters in western Prince William Sound, and physiological factors that may be involved in constraining recovery.

Chief Scientist's Recommendation

This proposal would measure gene expression in peripheral blood mononuclear cells of sea otters from three sites in Prince William Sound, representing oiled and unoiled (reference) areas. It is thought that differences in expression of the selected genes will indicate whether the continuing exposure to oil might be linked to health effects in those animals. The observations driving the studies are the elevated levels of CYP1A expression in sea otters from some areas, and the evidence suggesting lack of growth and/or "poor health" of sea otters from oiled areas. It is of some interest to the Trustee Council to determine if there are indications of low level chronic stress, including immune disorders, linked to continuing oil exposures in sea otters in western Prince William Sound. However, there is yet no proof of principle that the novel methods proposed here measure responses that are induced by oil exposure, although such information would be gathered during the course of the project. In addition, the technical approach is incompletely described, and it is uncertain if the molecular techniques for detecting immunological responses can be successfully carried out as proposed. Do not fund.

Executive Director's Recommendation

Do not fund. This project, which would use blood drawn from sea otters under Project 01423, is intended to determine whether continuing exposure to oil might be linked to health effects in those animals. However, the Chief Scientist has raised concerns about the proposed methods and whether the techniques can be successfully carried out as planned.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02663	"Watchdog Tool" for Sampling and Monitoring	J. Rusher/Rusher's Services	ADEC	New 1st yr. 1 yr. project	$180.9	$0.0	$0.0	$0.0

Project Abstract

A sampling tool called the "Watchdog Tool" will be placed on surface or pits of beaches and sensitive areas where weathered oil may be leaching out. Quality control testing of the "Watchdog Tool" will be done to tell if weathered oil is leaching out or coming in from subtidal areas. This project will also identify the toxicity of weathered oil.

Chief Scientist's Recommendation

It is unclear as to what is being proposed (what is the watchdog tool?) and how the "tool" is being applied to meet the objectives of detecting oil that may be leaving sediments and its toxicity. Without a description of methodology, proper evaluation of the proposal is impossible. Do not fund.

Executive Director's Recommendation

Do not fund. This proposal is unclear and lacks a description of the methodology necessary for evaluating it.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02673	Continuing Decline of Pigeon Guillemots in the Oiled Portion of Prince William Sound	D. Irons/USFWS, D. Roby/OSU	DOI	New 1st yr. 5 yr. project	$28.7	$0.0	$29.5	$0.0

Project Abstract

Pigeon guillemots have declined 56% in Prince William Sound since the *Exxon Valdez* oil spill. This is compounded on a 73% decline from 1972 to 1989. Taken together pigeon guillemots have declined 88% since 1972, and the decline is continuing. This project will investigate factors that are causing the continued decline of guillemots in Prince William Sound. From previous work we suspect one or more of three major factors are causing the decline: reduced prey base, increased predation, or continuing oil effects. The first year the study will focus on food and predation, as analyses for oil effects is more expensive. [Note: This project also requested funding for FY 04 ($30,500), FY 05 ($31,500), and FY 06 ($32,500).]

Chief Scientist's Recommendation

This proposal from highly qualified investigators would perform long-term monitoring of pigeon guillemot populations in Prince William Sound at a relatively low cost. This may be the type of monitoring that could be included in GEM, especially with the proposed matching funds from the agency. However, it would be premature to begin the project in FY 02 as the indicators of long-term ecological change in the nearshore environments have yet to be determined for GEM. Do not fund.

Executive Director's Recommendation

Do not fund. This project, which would fund five years of pigeon guillemot monitoring at Naked Island to determine if poor productivity is causing the continued population decline, may be the type of monitoring that is included under GEM. However, it is premature until the indicators of long-term ecological change that GEM will monitor have been determined.

Spill Recovery Monitoring					$846.4	$660.4	$331.5	$0.0
02012-BAA	Photographic and Acoustic Monitoring of Killer Whales in Prince William Sound and Kenai Fjords	C. Matkin/North Gulf Oceanic Society	NOAA	Cont'd 10th yr. 10 yr. project	$35.2	$35.2	$0.0	$0.0

Project Abstract

This project will close out the monitoring of the damaged AB resident pod and the potentially endangered AT1 transient population as well other Prince William Sound/Kenai Fjords killer whales. Monitoring has occurred on a yearly basis since 1984. Analysis of FY 01 data will be completed, as well as additional modeling of the resident killer whale population and AB pod and publication of those results. Remote hydrophone data will be collected through December 2001 and data from all years will be summarized and assesed. Distribution of killer whales in Kenai Fjords over the course of the project will be examined using GIS techniques. A final examination of resident killer whale prey will be made using samples collected from 1997-2001. A final report will be submitted.

Chief Scientist's Recommendation

This proposal would continue a 12-year study of population trends of killer whales in Prince William Sound. The principal investigator has made major contributions to characterizing the populations of killer whales and understanding killer whale biology in the northern Gulf of Alaska. It is not clear that we need to continue surveys on an annual basis in order to track the AB pod and AT1 group, although some aspect of killer whale ecology could be a component of GEM. Fund closeout only in FY 02 (no field work), contingent on delivery of past due manuscripts.

Executive Director's Recommendation

Fund closeout of this project contingent on submittal of overdue manuscripts (mating systems and niche partitioning). This project has provided valuable information about the long-term effects of the oil spill on resident and transient pods of killer whales in Prince William Sound. Annual surveys do not appear to be necessary to track the AB pod and AT1 group.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02144	Common Murre Population Monitoring	D. Roseneau/USFWS	DOI	Cont'd 7th yr. 7 yr. project	$14.8	$14.8	$0.0	$0.0

Project Abstract	Chief Scientist's Recommendation	Executive Director's Recommendation
FY 02 will provide closeout funds for this project, which will census the Chiswell Islands murre colonies during the FY 01 field season. The closeout work will consist of analyzing the data collected during FY 01 and comparing these results with previous postspill population counts, running a power analysis using these and other murre population count data (e.g., from the Barren Islands), and writing a final report discussing the recovery status of murres at this injured nesting location and in the spill area.	Analysis of the census data is necessary to the success of the murre monitoring effort. The work is reasonably straightforward, inexpensive, and undertaken by capable personnel. The results of the analyses and description of trends in abundance at each of the islands and at the complex as a whole will be useful in refining census methodologies and in understanding variability in murre populations in the Gulf of Alaska. As recommended last year, a power analysis should also be prepared. Fund.	Fund project closeout, including power analysis. This project censused the common murre colony at the Chiswell Islands in FY 01. The results of this project will be useful in refining census methodologies and in understanding variability in murre populations in the Gulf of Alaska.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02159	Surveys to Monitor Marine Bird Abundance in Prince William Sound During Winter and Summer 2002	D. Irons/USFWS	DOI	Cont'd 9th yr.	$194.1	$194.1	$25.0	

Project Abstract	Chief Scientist's Recommendation	Executive Director's Recommendation
This project will conduct small boat surveys to monitor abundance of marine birds and sea otters in Prince William Sound during March and July 2002. Seven previous surveys have monitored population trends for 65 bird and 8 marine mammal species in the sound. Data collected in 2002 will be used to examine trends from summer 1989-2002 and winter 1990-2002. Data collected in 2000 indicate that bald eagles are increasing in winter and summer throughout the sound, harlequin ducks are increasing in the oiled area in winter, and black oystercatchers are increasing thoughout the sound in summer. Common loons, cormorants, and common murres are showing no trend in the oiled area; pigeon guillemots and marbled murrelets are declining in the oiled areas of the sound; and Kittlitz's murrelet is declining throughout the sound. Results of these surveys through 1998 have been published. [Note: This project also requested $25,000 for FY 04.]	In the long term, surveys of the kind proposed here will be needed to assess trends of populations of injured and indicator species of marine birds and mammals in Prince William Sound. It is still not clear that we need to do this as frequently as is being proposed, given the apparent continuing differences between oiled and unoiled areas in the sound over the last twelve years. The project is relatively expensive, and it is not clear why this task should not be part of normal agency management. Fund lower priority.	Defer decision on funding this project to December, pending availability of funds. The Trustee Council has supported boat surveys of marine birds and mammals in Prince William Sound since the time of the spill. These surveys have been the primary means of monitoring the recovery of a suite of coastal birds and other wildlife. However, as the transition to GEM begins, there is a question about whether it is essential that the surveys continue to be done every two years. In addition, the question of whether these are routine surveys that should be incorporated into the agency's normal management procedures needs to be revisited.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02245	Community-Based Harbor Seal Management and Biological Sampling	V. Vanek/ADFG, M. Riedel/Alaska Native Harbor Seal Commission	ADFG	Cont'd 9th yr. 9 yr. project	$26.8	$26.8	$0.0	$0.0

Project Abstract

Under this project, village-based technicians are selected by the Alaska Native Harbor Seal Commission and trained by the Alaska Department of Fish and Game to collect biological samples from harbor seals. The samples are transported to Anchorage or Kodiak for further sampling and distribution to participating scientists for analysis and the University of Alaska museum for archiving. In FY 02, the sample collection program in Prince William Sound and lower Cook Inlet, around Kodiak Island, and along the Alaska Peninsula will continue. The Alaska Native Harbor Seal Commission will produce and distribute a newsletter with summaries of the biological sampling program. FY 02 is the closeout year for this project.

Chief Scientist's Recommendation

This has been a highly successful program for involving the subsistence community in research on a valuable resource. The scientific community has benefited from obtaining samples of harbor seal tissues that were otherwise unavailable. A large number of projects have used samples from this activity in the past and there appears to be a use for samples currently being archived and which may be analyzed in the future. However, the information in the Detailed Project Description with regard to the number of tissue types sampled and the distribution of collection sites for the samples has not been updated. Also, in FY 01 the Trustee Council requested that this program coordinate with other statewide programs on harbor seals and this issue is not addressed. Fund revised proposal, which addresses these issues.

Executive Director's Recommendation

Fund revised proposal, which updates information on (a) the number of seals and tissue types sampled, (b) the distribution of the samples collected, (c) the sample database, and (d) activities undertaken to integrate the EVOS biosampling program with efforts underway statewide by the Alaska Native Harbor Seal Commission, the National Marine Fisheries Service, the Alaska Department of Fish and Game, the United States Geological Survey, and others, contingent on submittal of the 00245 report (due July 31, 2001). This project will continue the Alaska Native Harbor Seal Commission's biological sample collection program for harbor seals in the spill area. This multi-year project has successfully provided samples to harbor seal researchers. FY 02 was expected to be the final year of Council support, but this might be the type of community effort that is appropriate under GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02333	Sea Otter Monitoring	B. Henrichs/Native Village of Eyak	DOI	New 1st yr. 5 yr. project	$100.0	$0.0	$100.0	$0.0

Project Abstract

The sea otters in Orca Inlet have been dying and washing up on the beaches the past few years. The problem is getting worse. We know the cause. We need to do some monitoring to find a way to prevent these needless deaths. [Note: Funding ($100,000 each year) has also been requested for FY 04, FY 05, and FY 06.]

Chief Scientist's Recommendation

The U.S. Fish and Wildlife Service has conducted aerial surveys in Orca Inlet using non-EVOS funds each year since 1993. The data are characterized by high variance in some years, with the 2000 density estimates as high or possibly higher than anywhere in the North Pacific (roughly 16 sea otters per square kilometer in Orca Inlet vs. an average for all of Prince William Sound of 1 per square kilometer). Furthermore, any observed sea otter mortality in Orca Inlet is likely not related to the oil spill. Do not fund.

Executive Director's Recommendation

Do not fund. Any observed sea otter mortality in Orca Inlet is likely not related to the oil spill, and this project's link to the Trustee Council's restoration objectives is weak. In addition, results of U.S. Fish and Wildlife Service aerial surveys of Orca Inlet indicate 2000 density estimates as high or possibly higher than anywhere in the North Pacific.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02407	Harlequin Duck Population Dynamics	D. Rosenberg/ADFG	ADFG	Cont'd 3rd yr. 3 yr. project	$68.7	$68.7	$0.0	$0.0

Project Abstract

Harlequin duck populations have not recovered from the effects of the oil spill. Populations are declining in oiled areas of Prince William Sound while increasing in unoiled areas. This project will conduct late-winter boat surveys to assess the recovery of ducks inhabiting oiled areas. Population structure, abundance, and recruitment will be compared between oiled and unoiled areas in Prince William Sound to assess trends, population dynamics, and the progress of recovery. The surveys will also help identify changes to the Gulf of Alaska ecosystem and improve the ability to differentiate between natural and man-caused population changes. FY 02 will be the final year of field work for the project; the final report will also be prepared in FY 02.

Chief Scientist's Recommendation

The data generated by this project are valuable and fit well with information gathered by Project /423 (Population Change in Selected Nearshore Vertebrate Predators). Together these projects should increase understanding of harlequin duck populations in Prince William Sound in relation to the oil spill. In FY 02, data gathering should be concluded and a final report, including an assessment and reevaluation of survey design for long-term monitoring, should be prepared. Fund contingent on satisfactory review of a revised proposal that revises the project's scope as described above.

Executive Director's Recommendation

Fund contingent on (a) submittal and approval of a revised Detailed Project Description and budget that combine one more year of data collection in FY 02 as well as production of a final report, including assessment and reevaluation of a survey design for long-term monitoring and (b) submittal of 00273 and 00407 reports, due September 2001. This project is intended to assess the recovery of harlequin duck populations inhabiting oiled areas. The harlequin duck is one of the species that is still not showing signs of recovery from the oil spill.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02441	Harbor Seal Recovery: Effects of Diet on Lipid Metabolism and Health	R. Davis/Texas A&M	ADFG	Cont'd 4th yr. 4 yr. project	$20.2	$20.2	$0.0	$0.0

Project Abstract

This project will complete the analysis of samples that were taken by this project in earlier years. In addition, a final report and five manuscripts will be prepared. Analysis of the remaining samples is needed to resolve the temporal scale of changes in fatty acid composition under different diets, and will allow better interpretation of field data for wild harbor seals.

Chief Scientist's Recommendation

The Trustee Council's primary interest in funding this project has been to understand the dynamics of fatty acid profiles in harbor seals with different diets and changes in those diets. This project was to close out in FY 01 but the investigator has proposed additional analyses. In reviewing the Detailed Project Description, it appears that analysis of additional samples for fatty acid profiles will help obtain project objectives. Fund revised proposal, which focuses on fatty acids.

Executive Director's Recommendation

Fund closeout of this project (completion of fatty acid data analysis and final report and manuscript preparation). This study, which is investigating the effect of diet on lipid metabolism and health in harbor seals, received closeout funds in FY 01. A small amount of additional funds is needed in FY 02 to complete data analysis and prepare the final report. Five manuscripts will also be prepared.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02457-BAA	Monitoring the Fall-Winter Herring Biomass to Track the Recovery of the Prince William Sound Herring Stock	R. Thorne/PWSSC	NOAA	New 1st yr. 2 yr. project	$86.0	$0.0	$85.6	$0.0

Project Abstract

The herring population in Prince William Sound has declined about fifty-fold since the oil spill and is in a virtual state of collapse. Recent infrared scanning surveys have revealed intense predator activity on overwintering aggregations of herring, which includes several predators that are either threatened or oil-damaged species. The spill is implicated as a factor in this decline. A limited monitoring program has been maintained by the Oil Spill Recovery Institute and the Alaska Department of Fish and Game. Because of the critical state of this resource and its importance to the health of the sound, this project will expand the survey effort by including fall surveys of adults and juveniles as a measure of mortality and an early indicator of future recovery.

Chief Scientist's Recommendation

This project would track the fall biomass of Pacific herring in Prince William Sound, which is feasible. The project objective is to document overwintering mortality in adults, which may be significant. However, to manage the fishery the most important information is adult biomass just prior to spawning in the late winter to early spring. In addition, herring research priorities have been established in a series of workshops over the last several years. The objectives of this project were not a priority in the workshop recommendations. Do not fund.

Executive Director's Recommendation

Do not fund. A workshop sponsored by the Trustee Council in November 2000 resulted in several recommendations for future herring research, and this proposal was not among them. In addition, this proposal is for a fall survey (October/November) in order to document overwintering mortality in adult herring, and the reviewers have indicated that the most important information from a management standpoint is adult biomass just prior to spawning in the late winter/early spring. The November 2000 workshop recommendations included ASA hindcasting to estimate the herring spawning biomass in Prince William Sound in recent years, use of otoliths and lipids to identify subpopulations of herring within the sound, and aerial surveys. A proposal (Project 02538) was received for otolith/lipids work, and is recommended for funding.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02462-CLO	Effects of Disease on Pacific Herring Population Recovery in Prince William Sound	G. Marty/Univ. of California, Davis	ADFG	Cont'd 4th yr. 4 yr. project	$77.4	$77.4	$0.0	$0.0

Project Abstract

The Pacific herring population of Prince William Sound has not recovered from severe population decline in 1993. The Alaska Department of Fish and Game now predicts that fisheries closed since 1999 will not open for several years. Long-term systematic disease monitoring and research since 1994 has shown a clear relationship between disease prevalence and population change, and this information significantly improves the ability to forecast population change. Because of the importance of Pacific herring in the Prince William Sound ecosystem, and the importance of this project to marine fisheries worldwide, an additional year of disease study is proposed to ensure seamless flow of data from this project to GEM.

Chief Scientist's Recommendation

Lack of recovery of Pacific herring has resulted in lost services for commercial fisheries and lost resources for subsistence use. The proposed study through 2002 will provide nine years of pathogen prevalence and disease information, making this the most comprehensive study ever conducted on a wild fish population. Following this population through a full cycle estimated to be 16-20 years would be optimal to understand how pathogen presence, disease and population size are linked. However, funding constraints, and other restoration and GEM priorities preclude a commitment of such duration. Furthermore, other components associated with ecosystem health must also be included in the analysis (e.g., food availability). Manifestation of disease and potential population impacts are determined by environmental factors, not just pathogen presence. Fund for FY 02 only.

Executive Director's Recommendation

Fund closeout of this project, including preparation of a final report. This project is designed to determine whether disease continues to limit recovery of the Prince William Sound herring population. The herring population biomass in the sound is at the lowest level ever recorded. A substantial grant from the National Science Foundation, up for renewal this year (new project dates would be February 2002 through January 2007), has enabled the investigators to perform complementary analyses and population modeling.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02558	Harbor Seal Recovery: Application of New Technologies for Monitoring Health	S. Atkinson/UAF	ADFG	Cont'd 2nd yr. 3 yr. project	$128.4	$128.4	$85.6	

<u>Project Abstract</u>

This project will investigate the potential for new technologies to assess and monitor the endocrine and immune systems as diagnostic measures of the health of harbor seals. Analysis of thyroxine (T_4), triiodothyronine (T_3), and cortisol (primary metabolic and gluconeogenic hormones), and measurement of immunoglobulins (IgG, IgM, and IgA) and the body burden of organochlorine contaminants will provide an assessment of both permanently captive seals as well as seals that are brought into the Alaska SeaLife Center for rehabilitation. Once the profiles of healthy seals and those failing to thrive in their natural environment are assessed, these techniques will be evaluated for routine monitoring of free-ranging seals in an effort to restore this species.

<u>Chief Scientist's Recommendation</u>

This project is documenting changes in the immune and endocrine markers in the blood of captive harbor seals, and will use rehabilitating seals to determine if such measures have a relationship to contaminants. The project is on track to meet its objectives: assays have been validated, monoclonal antibodies for harbor seal immunoglobulins are being developed, and blood samples have been analyzed for thyroid hormones. Fund.

<u>Executive Director's Recommendation</u>

Fund. This project is employing new technologies at the Alaska SeaLife Center to assess and monitor the health of harbor seals. [Note: Funding of $163,900 for Alaska SeaLife Center bench fees for this project is currently included under Project 02350.]

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02574-BAA	Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound	D. Lees/Littoral Eco.& Environ. Services	NOAA	New 1st yr. 2 yr. project	$94.8	$94.8	$35.3	

<u>Project Abstract</u>

Studies from 1989 through 1997 suggest that bivalve assemblages on beaches in Prince William Sound with high-pressure hot-water washing remain severely damaged in terms of species composition and function. This project will assess the generality of this apparent injury to these assemblages. A finding that our conclusions are accurate will indicate that a considerable proportion of mixed-soft beaches in treated areas of the sound remains extremely disturbed and that these beaches are functionally impaired in terms of their ability to support foraging by damaged nearshore vertebrate predators such as sea otters and harlequin ducks. The study will also provide insight into the need for remediation of beaches to restore biodiversity and function on these assemblages.

<u>Chief Scientist's Recommendation</u>

This proposal would extend sampling initiated under the National Oceanic and Atmospheric Administration's HAZMAT program to document continuing effects of shoreline cleanup on populations of important bivalves. This would allow the conclusions drawn in the HAZMAT studies to be generalized over a larger geographic range within the oil spill area. The removal of fine sediments by shoreline cleanup and the subsequent biological consequences appear to be long-term effects of the spill. The proposal is well prepared and the principal investigator has been responsive to past comments in reducing the scope and cost of the effort. However, there is no compelling evidence that the work would reach the peer reviewed literature where this information would be of most value to restoration efforts. In addition, the uncertainty over treatment history of shorelines casts some doubt on the feasibility of the project. Defer pending submission and evaluation of revised proposal.

<u>Executive Director's Recommendation</u>

Defer decision on funding this project to December, pending review of a revised Detailed Project Description that addresses the Chief Scientist's concerns (further development of shoreline treatment history and preparation of results for peer reviewed literature). This proposal would extend sampling initiated under the National Oceanic and Atmospheric Administration's HAZMAT program to document continuing effects of shoreline cleanup on populations of important bivalves, thus allowing the results to be generalized over a larger geographic range. This would be a worthwhile endeavor.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
Ecosystem Recovery & Function					$1,201.3	$544.9	$689.0	$189.0
02163-BAA	Alaska Predator Ecosystem Experiment in Prince William Sound and the Gulf of Alaska (APEX)	D. Duffy/Paumanok Solutions	NOAA	Cont'd 9th yr. 8 yr. project	$31.1	$0.0	$0.0	$0.0

Project Abstract

This project will fund a third closeout year for Project /163, which used seabirds as probes of the trophic (foraging) environment of Prince William Sound and Cook Inlet, comparing their reproductive and foraging biologies, including diet. These measurements were compared with hydroacoustic, aerial, and net sampling of fish to calibrate seabird performance with fish distribution and abundance. This allowed a determination that food played a major role in limiting the recovery of seabirds from the oil spill. In FY 02, the project leader will prepare a semi-popular account of the results and implications of the project.

Chief Scientist's Recommendation

A popular account of the findings of the APEX project would be useful. However, the APEX project investigators have not finished analyzing their data and synthesizing the findings within or across studies. In addition, the investigators agreed last year that a scientific synthesis volume would be prepared in FY 02 following completion of the final report and summary papers currently underway, and there is no mention of this in the proposal. Do not fund this project in FY 02, but possibly consider proposal for a scientific synthesis volume in FY 03 following completion of the final report and publication of the summary papers.

Executive Director's Recommendation

Do not fund. Until final APEX results are submitted and reviewed (the final report was due September 30, 2000 but has not yet been completed; 13 summary scientific papers are to be completed by September 30, 2001), it is premature to pursue development of additional products from this project. Furthermore, the expected follow-up product, as described in the FY 01 Detailed Project Description (Project 01163), was a scientific synthesis (a book or special journal publication) of this multi-year, multi-faceted project. Only following such a synthesis should the Trustee Council consider a semi-popular account as is proposed here.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02163M	APEX: Numerical and Functional Response of Seabirds to Fluctuations in Forage Fish Density	J. Piatt/USGS	DOI	Cont'd 9th yr. 9 yr. project	$50.0	$50.0	$0.0	$0.0

Project Abstract

This project will fund preparation of synthesis manuscripts for this component of the APEX project. The main field program occurred in 1995-1999, with collection of data on seabird survival and stress continuing in 2000-2001. The work involved at-sea surveys for forage fish and seabirds and some characterization of oceanography, while measuring aspects of seabird breeding biology and foraging behavior at adjacent colonies.

Chief Scientist's Recommendation

This is a sound and logical conclusion of a large project. The principal investigator has done an excellent job of taking an ecosystem approach to understanding issues highly relevant to the Trustee Council. The long list of publications and theses attests to this project's scientific success so far. This publication effort is very important to the credibility and accountability of the EVOS restoration program. Fund.

Executive Director's Recommendation

Fund contingent on (a) submittal of overdue reports (00163/APEX chapter and 00501/Seabird Monitoring Protocols) and (b) submittal of the four manuscripts for which this principal investigator and his research team received funding under 01163/APEX Summary Scientific Papers (due September 30, 2001).

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02195	Pristane Monitoring in Mussels	J. Short, P. Harris/NOAA	NOAA	Cont'd 7th yr. 7 yr. project	$20.0	$20.0	$0.0	$0.0

Project Abstract

This project has focused on elucidating the transport mechanism of pristane from *Neocalanus ssp* copepods into mussels in Prince William Sound for the previous six years. In FY 00 and FY 01, the utility of monitoring the response of pristane in mussels to mass-release of juvenile pink salmon from Prince William Sound hatcheries was successfully initiated, using pristane concentration levels. This project will continue with this direction to assess feeding conditions for juvenile pink salmon during the critical period of initial marine residence, and will forecast survivals through this period. Forecasts will be compared to actual returns to assess reliability.

Chief Scientist's Recommendation

This project has developed a relationship over the last several years between concentrations of pristane in mussels (an indicator of food availability) in the early growing season and survival of hatchery pinks in Prince William Sound. As expected, however, the results also indicate that there are other important determinants of juvenile pink salmon survival in the early marine phase (some of those factors have been modeled with some success under the SEA/Sound Ecosystem Assessment project). This is not surprising, as many other efforts elsewhere in the world have shown the difficulty of predicting recruitment in marine fishes. The model developed by this project has made a valuable contribution to identifying ecological interactions that influence pink salmon survival. To bring the project to a logical and useful conclusion, the principal investigator should synthesize project results in FY 02, including preparation of a final report and publication of the project results in the peer reviewed literature. It may be that the results of this project could be utilized in a longer-term effort to better characterize the crucial factors influencing fish recruitment in the system. Fund closeout.

Executive Director's Recommendation

Fund contingent on (a) submittal and approval of a revised Detailed Project Description and budget that reduce the project's scope to closeout only (final report and manuscript) and (b) submittal of overdue report (00195) and manuscript (00598). This project has been working to develop an inexpensive measure of marine productivity that would allow predictions about future fisheries production and harvest levels.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02320	Sound Ecosystem Assessment (SEA): Printing the Final Report	W. Hauser/ADFG	ADFG	Cont'd 8th yr. 8 yr. project	$6.2	$6.2	$0.0	$0.0

Project Abstract

This project will print, bind and distribute the Sound Ecosystem Assessment (SEA) final report. The integrated final report is a required document expected to exceed 1,000 pages (some with color). Funding for copying, binding and mailing the final report was provided in FY 00, but completion has been delayed and the encumbered funds cannot be spent after June 30, 2001. The FY 00 unused funds will lapse.

Chief Scientist's Recommendation

Producing the SEA final report is essential, and this proposal seeks only to reauthorize funding that has expired. The principal investigator should do everything possible (as will the Chief Scientist) to ensure that the remaining chapter of the final report is completed so that the report can be produced and distributed. Fund.

Executive Director's Recommendation

Defer decision on funding this project to December, pending completion and peer review of the final report, when a better estimate of printing costs can be made (the above number is a placeholder). This same amount of funds was provided to the Alaska Department of Fish and Game in FY 00 (Project 00320) for printing the SEA final report, but under state rules those funds must lapse June 30, 2001. The expected completion date of the SEA final report is now September 30, 2001.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02372	Steller Sea Lion Monitoring	B. Henrichs/Native Village of Eyak	DOI	New 1st yr. 5 yr. project	$250.0	$0.0	$250.0	$0.0

Project Abstract

Steller sea lions are on the decline and have been placed on the endangered list. If this trend continues, subsistence fishing for salmon, herring and other marine life will be curtailed and some traditional areas may be closed. We need to monitor the interaction between the Steller sea lion and the fishing fleets. This proposal would fund this interaction. [Note: Funding ($250,000 each year) has also been requested for FY 04, FY 05, and FY 06.]

Chief Scientist's Recommendation

The concept presented requires more detail before it can be effectively evaluated. The issue raised is important to all fishers--subsistence, recreational, and commercial. The recent court decision on the National Oceanic and Atmospheric Administration's treatment of fishing interactions with Steller sea lions should result in sufficient scientific study and analysis of how fishing affects Steller sea lions to cover the needs identified by this proposal. Do not fund.

Executive Director's Recommendation

Do not fund based on Chief Scientist's recommendation. The recent court decision on the National Oceanic and Atmospheric Administration's treatment of fishing interactions with Steller sea lions, as well as the additional funds provided by Congress for Steller sea lion studies, should result in sufficient scientific study and analysis of how fishing affects Steller sea lions to address the concerns raised by the proposal.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02396	Alaska Salmon Shark Assessment	J. Rice, L. Hulbert/NOAA	ADFG	Cont'd 3rd yr. 3 yr. project	$28.8	$28.8	$0.0	$0.0

Project Abstract

This project will fund a closeout year of data analysis and manuscript preparation for this two year study of salmon sharks in Prince William Sound. Funding will cover analysis and final write-up of (a) data transmitted from satellite tags deployed on salmon sharks that will be scheduled to transmit during winter and spring of 2002, (b) data transmitted from satellite tags deployed on salmon sharks that will transmit when sharks frequent surface waters during summer, and (c) stomach samples collected during 2001 field sampling and pre-arranged stomach sample collections from the Copper River gillnet fleet and the Prince William Sound salmon seine fleet during the 2001 commercial fishing season. The funding will also cover FY 02 Argos time, NOAA Joint Tariff Agreement costs for satellite tag data recovery, and contracted data analysis. The final report will describe salmon shark movements, habitat utilization, regional fidelity, and diet composition from data collected during the project.

Chief Scientist's Recommendation

This is a competently prepared proposal that will finish gathering data from tags deployed on sharks in FY 01, analyze the data, and produce a final report. The investigators are well qualified to do the work. Fund.

Executive Director's Recommendation

Fund. In FY 02, this project will analyze data from tags deployed in FY 01 that will pop up in FY 02, as well as from opportunistic aerial observations and shark stomachs contributed by fishermen and others. A final report will also be written. This project was undertaken because of an observed increase in the number of sharks in Prince William Sound in recent years.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02401	Assessment of Spot Shrimp Abundance in Prince William Sound	C. Hughey/ Valdez Native Tribe, C. O'Clair/ NOAA	NOAA	Cont'd 4th yr. 4 yr. project	$25.5	$25.5	$0.0	$0.0

<u>Project Abstract</u>

This project is estimating the abundance of spot shrimp and determining the structure of the spot shrimp population in Prince William Sound. It augments current Alaska Department of Fish and Game (ADF&G) surveys to determine whether the spot shrimp population is recovering from depletion. Project results and those of ADF&G in 1999 and 2000 indicate a cessation in the apparent decline of spot shrimp abundance in western Prince William Sound that had taken place between 1992 to 1998, and a slight increase in the number and weight of spot shrimp per pot in 1999 compared to 1998. The increase was markedly greater in 2000. FY 02 will fund closeout, produce manuscripts, and provide input into the development of a shrimp management plan with ADF&G.

<u>Chief Scientist's Recommendation</u>

This is the fourth year of a four-year project to gather supplemental information on spot shrimp abundance in Prince William Sound. Fund closeout.

<u>Executive Director's Recommendation</u>

Fund closeout of this project, which is studying the abundance of spot shrimp in Prince William Sound to determine whether the population can sustain seasonal openings for subsistence, personal use, and commercial fishing. Shrimp are not on the injured resources list. However, the Trustee Council's Restoration Plan allows restoration actions to address resources not on the list if the action will benefit an injured resource or service; this project will benefit the services of subsistence and commercial fishing. The project is a joint effort of the Valdez Native Tribe and the National Oceanic and Atmospheric Administration's Auke Bay Lab.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02423	Patterns and Processes of Population Change in Selected Nearshore Vertebrate Predators	J. Bodkin, D. Esler/USGS-BRD, T. Dean/CRA, Inc.	DOI	Cont'd 4th yr. 5 yr. project	$329.7	$329.7	$189.0	$189.0

Project Abstract

Sea otters and harlequin ducks have not fully recovered from the oil spill. This project will explore links between oil exposure and the lack of population recovery, with the intent of understanding constraints to recovery of these species and the nearshore environment. In FY 02, sea otter work will include aerial surveys of distribution and abundance and estimates of age-specific survival rates. Harlequin duck field studies will examine the relationship between survival and CYP1A. Captive experiments on harlequin ducks will examine the relationships between oil exposure and CYP1A induction, and metabolic and behavioral consequences of exposure.

Chief Scientist's Recommendation

This is the fourth year of a complex project with field monitoring and laboratory dosing experiments at the Alaska SeaLife Center. The goals of this project are basically sound and the information that will be obtained valuable to the needs of the Trustee Council and to those trying to understand sea otters, ducks, and the nearshore ecosystem. The new objective to examine interannual variability in growth rates of clams is not compelling and should not be funded. Since the Council makes no commitment to fund beyond FY 02 as the restoration program transitions to GEM, sea otter field work should conclude in FY 02. There may be some justification for another year of harlequin duck field work in FY 03; that determination will be made following a review of harlequin duck recovery status next year--FY 03 would be another year of field work on harlequins or the closeout year, depending on the results of that review. Fund revised proposal, which addresses the above concerns.

Executive Director's Recommendation

Fund revised Detailed Project Description, which deletes the new objective related to growth rate of clams. The sea otter component will be closed out in FY 03. The harlequin duck component will be continued or closed out in FY 03; this determination will be made following a review of harlequin recovery status next year. The project is an important extension of the Nearshore Vertebrate Predator project (Project /025) work on two still-injured species, sea otters and harlequin ducks. [Note: Funding of $128,700 for Alaska SeaLife Center bench fees for this project is currently included under Project 02350.]

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02452-BAA	Assessing Prey and Competitor/Predators of Pink Salmon Fry	R. Thorne/PWSSC	NOAA	Cont'd 2nd yr. 1 yr. project	$38.9	$0.0	$0.0	$0.0

Project Abstract

Research shows that macro zooplankton and adult walleye pollock densities are the primary biological forcing variables effecting pink salmon fry survival. A program to make these estimates was initiated in spring 2000 by a partnership of organizations including the Oil Spill Recovery Institute (OSRI), Sound Emergency Response Vehicle System, and the Alaska Department of Fish and Game. The Trustee Council provided funds to expand this effort in 2001 (Project 01452), including interaction with Project 01195 which is studying the use of pristane concentration in mussels to estimate pink salmon fry survival. FY 02 funding will finalize the survey design and recommend procedures as a potential element in GEM, OSRI, or a combined institutional monitoring program.

Chief Scientist's Recommendation

This project involves the development and testing of acoustic sampling on a large scale to gather data on the abundance and distribution of key predators and prey of pink salmon fry. The information would be used in conjunction with related data from Project 02195/Pristane Monitoring to estimate fry survival, thus providing a basis for forecasts of adult pink salmon returns. However, because Project 02195 is not recommended for continuation in FY 02, the data that would be collected by this project is of lower priority for FY 02. Do not fund.

Executive Director's Recommendation

Do not fund. This project was funded for one year in FY 01 in conjunction with Project 01195/Pristane Monitoring. Because Project 01195 is recommended for closeout in FY 02, the data that would be collected by this project is of lower priority. The project should be closed out as planned in FY 01. If this project should be funded in the future, the funding would be contingent on submittal of a report that includes the reduced data (i.e., fish biomass) from the FY 01 effort (Project 01452). The project, which is performing spring hydroacoustic surveys in Prince William Sound, is designed to provide data on annual and seasonal variation of predators and food availability for juvenile pink salmon.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02479	Effects of Food Stress on Survival and Reproductive Performance of Seabirds	J. Piatt/USGS-BRD, A. Kitaysky/Univ. of Washington	DOI	Cont'd 4th yr. 4 yr. project	$55.0	$55.0	$0.0	$0.0

Project Abstract

Traditional field methods of assessing effects of fluctuations in food supply on the survival and reproductive performance of seabirds may give equivocal results. This project will apply an additional tool--the measure of stress hormones in free-ranging seabirds. Food stress can be quantified by measuring base levels of stress hormones such as corticosterone in the blood of seabirds, or the rise in blood levels of corticosterone in response to a standardized stressor--capture, handling and restraint. These techniques will be applied to seabirds breeding in lower Cook Inlet and captive birds will be used for controlled experiments. This project provides a unique opportunity for a concurrent field and captive study of stress in seabirds.

Chief Scientist's Recommendation

This proposal is for funding to synthesize and publish the results of three prior years of work on stress hormones in seabirds. The results of this work are relevant to interpreting the recovery status of murres and other seabirds and also, potentially, for design of a GEM monitoring protocol. However, two of the eight manuscripts proposed--those on the long-term effects of early nutritional stress on cognition and sexual maturation of young seabirds --are of lower priority and should be deleted. Fund revised proposal, which deletes these two manuscripts, contingent on submission of overdue reports and manuscripts.

Executive Director's Recommendation

Fund revised closeout proposal, which reduces the number of manuscripts as directed by the Chief Scientist, contingent on submittal of overdue reports (00163/APEX chapter and 00501/seabird monitoring protocols) and manuscripts (seasonal elevation of corticosterone and seasonal dynamics of corticosterone, both funded under Project 00479). This project is exploring the use of corticosterone, a biochemical indicator of stress, as a tool to monitor seabird populations. This work is also relevant to interpreting the recovery status of seabirds and possibly to design of a monitoring protocol for GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02503	Orca Inlet Restoration	B. Henrichs/Native Village of Eyak	DOI	New 1st yr. 5 yr. project	$100.0	$0.0	$150.0	$0.0

Project Abstract

Orca Inlet has become barren over the years. While it used to supply many of the subsistence resources to the residents of Eyak/Cordova, in recent years it has supplied very little. The 1964 earthquake raising the area resulted in a die-off of clams and crab. The expanding of the sea otters accelerated this. The shallowing of the inlet combined with the increase of fish waste dumped has resulted in a dead bay. We need to come up with a plan to restore Orca Inlet to what it was when we were children. [Note: Funding ($150,000 each year) has also been requested for FY 04, FY 05, and FY 06.]

Chief Scientist's Recommendation

No methods for restoration of Orca Inlet are proposed. The project's concept has not been linked to the Trustee Council's restoration objectives. In addition, it could entail considerable costs over a long period of time. Do not fund.

Executive Director's Recommendation

Do not fund. The project's concept has not been linked to the Trustee Council's restoration objectives. In addition, it could entail considerable costs over a long period of time. Long-term monitoring of sea otters may be considered as part of GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02546	Assessing Harbor Seals: Methods to Identify Metabolic Responses to Environmental Change	M. Castellini/UAF	ADFG	New 1st yr. 1 yr. project	$50.4	$0.0	$0.0	$0.0

Project Abstract

This project will provide final design and sensitivity testing for a sampling scheme and software approach to monitoring population-wide health patterns in harbor seals. Much like the concept of genetic fingerprinting, this method uses a novel blood chemistry fingerprinting technique that can easily separate subpopulations of animals based on a suite of 20-30 blood chemistry values. The proposers termed this method "Metabolic Identity" and intend to use it as the core of a long-running GEM proposal. The FY 02 project will conduct the pre-development testing of the method and test its strength and robustness.

Chief Scientist's Recommendation

This proposal is for the development of a blood chemistry profile method which may characterize subpopulations and/or fitness of individuals. The investigator is a very accomplished and able marine mammal biologist. The proposed methodology appears to be a potentially powerful tool that could supplement earlier work on regional genetic differences and geographic differences in food habits that are known to exist for harbor seals in the northern Gulf of Alaska. Further development of this concept as proposed is likely appropriate for assessing marine mammal populations in the Gulf of Alaska. However, the most appropriate strategy for accomplishing this work may be in partnership with concerned resource management agencies. Do not fund.

Executive Director's Recommendation

Do not fund. This proposal, which would develop a blood chemistry profile for identifying subpopulations of harbor seals, would have been more attractive if it had been submitted as a partnership with the resource management agencies.

SPRE/ HEET B: EXECUTIVE DIRECTOR'S RECON NDATION / FY 02 WORK PLAN

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02617	Standing Stock and Secondary Production of Zooplankton in Prince William Sound	R. Hopcroft, K. Coyle/UAF	ADFG	New 1st yr. 1 yr. project	$86.0	$0.0	$0.0	$0.0

<u>Project Abstract</u>

Understanding the seasonal cycles and inter-annual variability of zooplankton is essential for understanding the success of higher vertebrate trophic levels. Systematic sampling of the zooplankton in central waters of Prince William Sound was discontinued in 1997 with the completion of the SEA project (/320) and although the Gulf of Alaska GLOBEC program began in that same year, its sampling techniques are not comparable to the SEA and earlier data sets. This project will set the stage for GEM activities by enhancing current sampling within the GLOBEC program to allow direct comparison to earlier data sets, and integrate this with detailed analysis of recent nearshore zooplankton collected by Prince William Sound Aquaculture Corporation hatcheries.

<u>Chief Scientist's Recommendation</u>

This proposal would collect and report a substantial amount of data pertaining to the zooplankton community in Prince William Sound, for comparison with collections obtained by GLOBEC on the shelf and oceanic region south of Seward and with hatcheries in the sound. A plankton monitoring program will likely be a part of GEM, but any acoustic-net surveys in GEM should collect data on a wide size range of plankton, nekton, and fish. It would be more useful to GEM to examine some approaches (like this proposal) so that when the time comes to initiate long-term monitoring, there will be a basis for specifying the characteristics (e.g., sampling gear, frequency of samples, location of samples, sampling platforms, taxa) of that program. Developing a plan for a well-coordinated use of acoustics as part of GEM is more important than initiating sampling at this time in order to have data that can be compared to GLOBEC sampling. Do not fund.

<u>Executive Director's Recommendation</u>

Do not fund. Although a plankton monitoring program will likely be a part of GEM, it is premature to initiate data collection at this time. A plan for a well-coordinated use of acoustic-net surveys needs to be developed first.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02659-BAA	Preparation and Publication of Results from SEA and NVP Avian Predation Studies	M. Bishop/PWSSC	NOAA	New 1st yr. 1 yr. project	$29.7	$29.7	$0.0	$0.0

Project Abstract

This project will prepare (a) two manuscripts based on the work from the Avian Predation on Herring Spawn study (Project /320) and (b) one manuscript based on the work from the Avian Predation on Blue Mussels study (Project /025). The three manuscripts will be submitted to peer reviewed journals for publication. One publication on avian consumption of herring spawn is currently in press in *Fisheries Oceanography*.

Chief Scientist's Recommendation

This proposal would fund an additional three manuscripts based on work in the SEA (Sound Ecosystem Assessment, Project /320) and NVP (Nearshore Vertebrate Predators, Project /025) projects. The principal investigator has a good publication record and would likely produce the manuscripts. However, it is not clear from the proposal what previously unpublished material on herring roe predation would appear in the first two proposed manuscripts. It is also not clear what aspect of blue mussel predation would be the subject of the third manuscript. Defer pending submission of a revised proposal with more justification and detail.

Executive Director's Recommendation

Defer decision on funding this project to December, pending submittal and approval of a revised Detailed Project Description that clarifies what previously unpublished material would be the subject of the three manuscripts proposed. If funded, funding would be contingent on resolution of budget questions.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02669	Hooligan Research	B. Henrichs/Native Village of Eyak	DOI	New 1st yr. 2 yr. project	$100.0	$0.0	$100.0	$0.0

Project Abstract

The Alaska Department of Fish and Game has been selling permits to commercially harvest hooligan for the past two years. We are concerned because they cannot tell us what the biomass is. Hooligan are a traditional subsistence food and a forage food for birds, fishes, and marine mammals, including Steller sea lions. There have been no commercial herring openers in years, because they have been over-fished. It doesn't make sense to start a commercial fishery on hooligan when the commercial fishery on herring resulted in a depletion of those stocks. This project proposes independent research on hooligan to see if it can sustain a commercial harvest and still maintain the stocks for traditional subsistence harvest.

Chief Scientist's Recommendation

This proposal correctly identifies an important problem in management of subsistence fish resources that is a part of normal agency management. The proposal does not present any specifics that can be evaluated. Do not fund.

Executive Director's Recommendation

Do not fund. This proposal expresses the concern that the commercial harvest of hooligan may threaten the availability of these fish for subsistence users and as forage for other species, and requests that research be conducted to determine if hooligan can sustain a commercial harvest. While this may be a legitimate concern, allocation of fisheries resources among various user groups is the function of the Alaska Board of Fish and the Alaska Department of Fish and Game, and is beyond the purview of the Trustee Council.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
Spill General Restoration					$549.6	$75.4	$109.9	$0.0
02154	Archaeological Repository, Display Facilities, and Exhibits for Prince William Sound and Lower Cook Inlet	J. Bittner/ADNR	ADNR	Cont'd	$29.1	$29.1		

Project Abstract

In January 1999, the Trustee Council authorized $2.8 million for a grant to Chugachmiut, Inc. to develop an archaeological repository for Prince William Sound and lower Cook Inlet, local display areas in seven communities in those regions, and traveling exhibits to display in the local facilities. The resolution also states the Council's intent to provide a reasonable amount of funding for project management and agency general administration (GA). This project will provide project management and GA funds for FY 02.

Chief Scientist's Recommendation

Proposal not reviewed.

Executive Director's Recommendation

Fund. This project will provide essential oversight for the archaeological repository, local display facilities, and traveling exhibits being developed under Project 99154. [Note: This project will be funded outside of the regular FY 02 work plan of research, monitoring, and general restoration projects.]

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02247	Kametolook River Coho Salmon Subsistence Project	J. McCullough, L. Scarbrough/ADFG	ADFG	Cont'd 6th yr. 6 yr. project	$30.8	$30.8	$0.0	$0.0

Project Abstract

Subsistence users from the Alaska Peninsula Native Village of Perryville have noted significant declines in the coho salmon run in the nearby Kametolook River since the oil spill. Criminal settlement funds were used in FY 96 to determine what method would best restore the river's coho salmon stock to historic levels. This project will provide funding through FY 02 for the Alaska Department of Fish and Game to try conservative and safe restoration methods. In 1997, two instream incubation boxes were installed in the upper reach of the Kametolook River. In 1998, 1999, and 2000 holding pens were also used. Due to continual low escapement of coho into the Kametolook River system, the project will be unable to achieve the goal of restoration within two life cycles of the fish. In FY 01, the project will expand to investigate nearby coho stocks as potential brood sources for rehabilitation of the Kametolook coho run.

Chief Scientist's Recommendation

This project is an integral part of a cluster of projects aimed at restoring damaged subsistence resources. Despite a limited success in restoring and supplementing Kametolook River coho thus far, the project is important because it directly addresses a subsistence issue, has strong community involvement, and holds potential for some success. There is a strong educational component as well. Fund final year of activities in FY 02, including project closeout.

Executive Director's Recommendation

Fund, including new objective related to investigating nearby coho stocks as potential brood sources, contingent on submittal of 00247 annual report (due August 15, 2001). This project is working to enhance a small coho salmon run in the Kametolook River near the Alaska Peninsula village of Perryville as a replacement for other subsistence resources lost or reduced due to the oil spill. The project has a strong community involvement component. FY 02 is expected to be the final year of Trustee Council funding, even though it is unlikely that the run will be self sustaining in the foreseeable future.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02256B-CLO	Sockeye Salmon Stocking at Solf Lake	D. Gillikin/USFS	USFS	Cont'd 7th yr. 7 yr. project	$15.5	$15.5	$0.0	$0.0

Project Abstract

This project will benefit subsistence users of western Prince William Sound. There are two phases to the project. Phase 1, which began in FY 96, verified the ability of Solf Lake to support a sustainable population of sockeye salmon. Phase 2 included stocking the lake with approximately 100,000 sockeye salmon fry, then ensuring access to the lake for returning adult salmon. The stocking program began in 1998 along with modification to the two outlets to control water levels. The reconstruction of the fishway in the eastern channel was completed in the summer of 2000. Returning adult salmon to Solf Lake will be monitored starting in 2001 to evaluate the improvements.

Chief Scientist's Recommendation

This project is an integral part of a cluster of projects aimed at restoration of oil-damaged, subsistence resources in Prince William Sound. Initial limnological studies and revitalization of the fishway to the lake have been completed, but changes in brood stock (from Eyak and Coghill lakes) and unavailability of brood stock in FY 02 have raised questions about the ability of the project to meet its objectives. In FY 01, the Trustee Council requested preparation of the final report in FY 02, and this still seems appropriate. The proposed FY 03 activities are not recommended for funding. Fund revised proposal, which closes out the project in FY 02.

Executive Director's Recommendation

Fund revised proposal, which reduces the scope of the FY 02 project to monitoring and final report writing only. This project is intended to provide sockeye salmon as a replacement for resources lost or reduced due to the oil spill. Recreational, commercial, and subsistence fishers should all benefit from the project.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02416	O'Brian Creek Enhancement	Chenega Bay IRA Council	USFS	New 1st yr. 1 yr. project	$64.2	$0.0	$0.0	$0.0

Project Abstract

Several stream habitat constraints exist within O'Brian Creek which is located near the village of Chenega Bay. Improvements to the stream would benefit the numerous fish species that use the habitat as well as the entire local ecosystem. The main goal of the project is to increase the depth of water by creation of a series of dam and fish ladder structures. Species that populate the stream include pink salmon, chum salmon, coho salmon, sockeye salmon, Dolly Varden, and cutthroat trout. A self-sustaining subsistence use fishery would be priceless for the community, as well as adding potential for promoting tourism and recreation.

Chief Scientist's Recommendation

This project proposes to restore anadromous fish production in O'Brian Creek. The Trustee Council has considered this project in the past. The proposal has worthy objectives but questions about feasibility of proposed methods cast doubt on whether lasting benefits could be obtained. Costs have been substantially underestimated and funds for essential items, such as spawning gravels, have not been provided for in the budget. Do not fund.

Executive Director's Recommendation

Do not fund. This proposal, which would construct instream enhancements in O'Brian Creek (dams, fish ladders, brood pond) as well as observation decks and walkways, was considered by the Trustee Council in previous years (FY 99 and FY 00). The project is designed to reestablish a coho run in O'Brian Creek near the village of Chenega Bay as a replacement for other subsistence resources lost or reduced due to the oil spill. Given the availability of salmon from other sources, there appears to be little need for this increased production. In addition, the Chief Scientist has raised questions about the project's feasibility.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02507	Nuchek Subsistence Camp	B. Henrichs/Native Village of Eyak	DOI	New 1st yr. 1 yr. project	$125.0	$0.0	$0.0	$0.0

Project Abstract

As a result of the oil spill the availability of subsistence foods have changed. The residents of the spill region are spending more time gathering traditional subsistence foods. A subsistence camp at Nuchek would allow the youth and elders to address these changes. Many of the people in the region trace their ancestry back to Nuchek. As Chugach Alaska Corporation has built a facility at Nuchek and holds annual spirit camps, this would be an appropriate location for this subsistence camp.

Chief Scientist's Recommendation

The proposers have requested technical assistance in preparing a proposal for a subsistence camp at Nuchek. Insufficient detail is presented here to evaluate the proposal. Presumably such a camp would help subsistence users understand and adapt to changes in their subsistence resources. This concept may have had some merit in the years immediately following the oil spill, but twelve years after the oil spill the justification is not compelling. Do not fund.

Executive Director's Recommendation

Do not fund. The value and importance of subsistence camps and other activities that teach traditional methods of harvesting and other subsistence skills to youth is clear. However, proposals submitted to the Trustee Council in the past for subsistence camps were found not to be legally permissible. The Nuchek Spirit Camp was funded in 1995 and 1996 with EVOS criminal funds with the expectation that funding in future years would be provided by Chugach Alaska Corporation.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02662	Natural Life Restoration by Manipulation	J. Rusher/Rusher's Services	ADEC	New 1st yr. 1 yr. project	$103.0	$0.0	$0.0	$0.0

Project Abstract

This project will place bait in pits of beaches and sensitive areas where weathered oil may remain. Quality control testing of the bait would be done to tell if weathered oil is in the process of degrading by the movement of worms in the beach. The toxicity of weathered oil will also be identified. This bait manipulation of worms could accelerate the degradation of oil.

Chief Scientist's Recommendation

This proposal does not describe a methodology for achieving project objectives, making proper evaluation impossible. Do not fund.

Executive Director's Recommendation

Do not fund. This proposal is somewhat unclear and lacks a description of the methodology necessary for evaluating it.

SPREA HEET B: EXECUTIVE DIRECTOR'S RECOM NDATION / FY 02 WORK PLAN

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02677	English Bay River Sockeye Salmon Enumeration Project	C. Kvasnikoff/Nanwalek IRA Council	ADFG	New 1st yr. 2 yr. project	$182.0	$0.0	$109.9	$0.0

<u>Project Abstract</u>

This project will allow for improvements to and continuation of smolt and adult sockeye enumeration in the English Bay River drainage. Available funds have become scarce and the Nanwalek Salmon Enhancement Project has been forced to narrow its focus to absolutely essential components of the project that result in adult returns. The enumeration of out-migrating smolts and returning adult sockeye escapement is very important to village project personnel and Alaska Department of Fish and Game area management staff but without additional funding, these important tasks will not be able to continue. This project will help to improve the weir equipment and monitoring technology to enable more consistent and accurate data collection.

<u>Chief Scientist's Recommendation</u>

This is a well-presented proposal, but the technology it describes, although theoretically possible, is difficult and expensive to implement. A link to restoration objectives is not clearly established and normal agency management is a question here. The project appears premature in the context of GEM community-based monitoring development. Do not fund.

<u>Executive Director's Recommendation</u>

Do not fund. This project would continue the sockeye salmon project begun by the Chugach Regional Resources Commission (CRRC) in 1990, which involves incubating eggs from English Bay Second Lake at the Port Graham hatchery and net-pen rearing the fry back at Second Lake. The project also includes monitoring smolt outmigration, adult escapement, and key parameters (age, weight, etc.). The Chief Scientist has raised questions regarding the project's feasibility. In addition, taking over the continuing components of this project from CRRC at this late date in the restoration process is not a priority for the Trustee Council.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
GEM Transition: Strategies to Improve Monitoring					$799.2	$200.8	$158.1	$0.0
02395	Workshop on Nearshore/Intertidal Monitoring	T. Dean/Coastal Resources Associates, C. Schoch/Kachemak Bay NERR	DOI	New 1st yr. 1 yr. project	$63.6	$63.6	$0.0	$0.0

Project Abstract

This project will produce a draft nearshore monitoring plan that provides a framework for future monitoring. A preliminary draft plan will be developed by the principal investigators that includes consideration of existing programs in the Lower 48 (e.g., PICES/North Pacific Marine Science Organization and PISCO/Partnership for the Interdisciplinary Study of Coastal Oceans) and Alaska (e.g., Prince William Sound and Cook Inlet Regional Citizens' Advisory Commissions). This draft will then be reviewed by a panel of four to five independent experts in nearshore marine ecology representing various interests and disciplines. A revised plan will be produced and presented to agencies, stakeholders, and other interest parties at a workshop held in conjunction with the EVOS Annual Workshop in January 2002.

Chief Scientist's Recommendation

A combined proposal is requested to include projects 02395 and 02569/Workshop on Gulf of Alaska Monitoring Network, with the overall objective of conducting a workshop to develop options for long-term monitoring of the nearshore/intertidal area. The revised proposal should include (a) community participation in the workshop, including funding for travel, (b) identification of the workshop objective as development of a range of options for intertidal monitoring design, for a network of sites, and broad community participation, (c) coordination with Trustee Council staff in putting together the workshop, (d) demonstration of a working relationship with other institutions and scientists supportive of the objectives of the workshop, including a list of expected participants, and (e) the process the principal investigators will use to cooperatively come to recommendations, including research priorities, once the workshop is complete. Fund contingent on successful review of revised proposal.

Executive Director's Recommendation

Fund contingent on submittal and approval of a revised Detailed Project Description and budget for the $63,600 requested, but that allocates within this amount $5,000 in travel funds for community participation in the workshop. This project will use a workshop-based approach to develop options for long-term monitoring of the nearshore/intertidal area. The workshop may identify pilot or preliminary work to be invited on nearshore/intertidal monitoring later in FY 02 or FY 03. A small amount of funds have been set aside for this purpose in FY 02 (see Project 02681). Nearshore/intertidal monitoring is expected to be an integral part of GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02532	Coupling of Oceanic and Nearshore: The Search for Indicator Species	G. Irvine/USGS	DOI	New 1st yr. 1 yr. project	$121.3	$0.0	$0.0	$0.0

Project Abstract	Chief Scientist's Recommendation	Executive Director's Recommendation
This project will (a) identify nearshore species whose abundances are coupled with low-frequency dynamic processes (e.g., regime shifts) occurring in the oceanic realm, and that could serve as sentinels of change for GEM, (b) examine other types of trends occurring for nearshore species with historical records (e.g., longer-term decline, increases, etc.), and (c) propose mechanisms that could be responsible for cyclical or directional changes in species abundances, thereby identifying processes that could also be monitored.	This is an interesting approach to answering an important suite of questions about linkage between fluctuations in inshore and offshore production. The work would possibly be useful to implementation of GEM in the future. However, the question is too large and complex to be answered adequately with the limited effort proposed. Further, I question the ability of the methods to allow detection of the climatic signal given the confounding nature of the other forces on the population to be sampled. Do not fund.	Do not fund. This proposal is a scaled-down version of a proposal submitted and not funded in FY 01. The research question embodied in the proposal is too large and complex to be answered adequately with the limited effort proposed. In addition, the Chief Scientist has raised questions about the project's methods.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02556	Mapping Marine Habitats: The First Step in a Spatially Nested Monitoring Program	C. Schoch/Kachemak Bay NERR	ADFG	New 1st yr. 1 yr. project	$50.0	$50.0	$0.0	$0.0

Project Abstract	Chief Scientist's Recommendation	Executive Director's Recommendation
Groups, individuals, and programs as diverse as natural resource agencies, local governments, researchers, conservation advocates in Cook Inlet and Kachemak Bay, and GEM can benefit from a comprehensive, high resolution database of shoreline and nearshore habitats, and from information on the physical changes seen through time. At present, no such detailed database or monitoring program exists within the Gulf of Alaska. This project will use a method adopted along the US west coast to gather such habitat information in a cost-effective yet detailed manner. The method relies on a nested hierarchical nearshore classification based on the physics of the environment to select replicate shore sites for monitoring algal and invertebrate diversity.	The GIS database of physical habitat features for intertidal and subtidal lands in Kachemak Bay could be a valuable baseline, and learning how to measure nearshore habitats in Kachemak Bay could provide a good starting point for intertidal monitoring for GEM. However, this project is premature considering the current status of GEM development. A workshop to develop options for long-term monitoring of the nearshore/intertidal under GEM is recommended for funding (Project 02395), and the proposer should participate in that workshop in order to integrate Kachemak Bay monitoring with broader GEM goals. Defer decision of whether or not to fund this project until after the workshop.	Defer decision on funding this project until the nearshore/intertidal workshop recommended for funding under Project 02395 has been held. The proposer should attend and participate in the workshop, which is designed to develop options for long-term monitoring of the nearshore/intertidal under GEM. This project would build a spatially comprehensive database of the geomorphology and physical attributes of subtidal and intertidal habitats in Kachemak Bay and quantify the physical attributes that force spatial variation in diversity of fish, invertebrate, and algal populations.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02565	Bottom-Up vs. Top Down: What Forces Control Variability in Kachemak Bay?	C. Schoch/Kachemak Bay NERR	ADFG	New 1st yr. 1 yr. project	$49.9	$0.0	$0.0	$0.0

Project Abstract

This project will establish intertidal and subtidal transects on rocky and sediment shores in Kachemak Bay and will study the relationship between bottom-up controls (current patterns, nutrient concentrations, phytoplankton distributions) and the spatial patterns of adult populations and their larvae over time. The primary goal is to understand the interaction of the nearshore oceanographic environment with coastal marine communities in the Gulf of Alaska. The project will partner with existing research and monitoring programs funded by the National Oceanic and Atmospheric Administration in Kachemak Bay and will adopt protocols developed by PISCO (Partnership for the Interdisciplinary Study of Coastal Oceans) .

Chief Scientist's Recommendation

This proposal appears to have merit and could be implemented in the future, although the methodology needs to be more fully developed. One of the potential strengths of this project is actual measurement of larval recruitment that might be understood in the broader context of oceanographic forcing. Overriding these conditions, the proposal is premature with respect to development of GEM. Results of activities conducted pursuant to Project 02395/Planning for Long-Term Monitoring in the Nearshore would need to be included in a revised proposal. Do not fund.

Executive Director's Recommendation

Do not fund. This project, which would establish intertidal and subtidal transects in Kachemak Bay with a goal of furthering understanding of the interaction of the nearshore oceanographic environment with coastal marine communities, is premature with respect to development of GEM. If this proposal is resubmitted in a future year, the Chief Scientist has recommended that the methodology be further developed and results from Project 02395/Planning for Long-Term Monitoring in the Nearshore be included.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02569	Linked Monitoring Network for the Gulf of Alaska: A Workshop	C. Schoch/Kachemak Bay Research Reserve, G. Eckert/UAS	ADFG	New 1st yr. 1 yr. project	$15.3	$0.0	$0.0	$0.0

Project Abstract

There are excellent research models such as PICES (North Pacific Marine Science Organization) and PISCO (Partnership for the Interdisciplinary Study of Coastal Oceans) in the Lower 48 that integrate oceanographic and shoreline components to study the effects of oceanic regime shifts on recruitment and growth of intertidal and shallow subtidal organisms. However, no such program exists in Alaska. This project will convene a workshop to bring together researchers from across the Gulf of Alaska region and the U.S. west coast to develop a coordinated research program for research and monitoring the neashore ocean of the North Pacific. A network of local research organizations acting in concert to adopt standardized protocols to address research questions at multiple spatial scales is envisioned.

Chief Scientist's Recommendation

Combine some concepts with Project 02395. See Project 02395 for recommendation.

Executive Director's Recommendation

Do not fund as a separate project, but combine some concepts with Project 02395. See Project 02395 for recommendation.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02601-BAA	GEM Transition: Addressing Methodological Data Gaps	T. Kline/ PWSSC	NOAA	New 1st yr. 2 yr. project	$189.5	$0.0	$85.0	$0.0

Project Abstract	Chief Scientist's Recommendation	Executive Director's Recommendation
Recent research using natural stable isotope abundance has shown that the advective regime connecting the northern Gulf of Alaksa with Prince William Sound may affect recruitment and nutritional processes in fish. Prince William Sound isotope data has also been used to measure relative trophic level. The trophic levels of landed fish appear to undergo long-term systematic shifts. Accordingly, GEM will need to use stable isotope abundance to address the effects of advective processes and anthropogenic trophic level effects on fish and other ecosystem components as part of long-term monitoring studies. However, there are presently data gaps in the stable isotope methodology that can be addressed within the next year using GLOBEC (Global Ocean Ecosystem Dynamics) and OSRI (Oil Spill Recovery Institute) sampling platforms. This study will (a) address inter-species isotope effects among macro-zooplankton taxa and (b) develop non-lethal isotope sampling for fishes.	This proposal would explore the application of natural stable isotope abundance data to establish spatial and temporal changes in macrozooplankton trophic level. The investigations would complement current work being carried out in the GLOBEC (Global Ocean Ecosystem Dynamics) program by the principal investigator. The investigator is well qualified with a reasonable publication record in the restoration program. Although trophic level shifts in macrozooplankton may indicate basic changes in ocean productivity, it is not certain that monitoring of this indicator will occur in GEM. Proposal is premature. Do not fund.	Do not fund based on Chief Scientist's recommendation. Although trophic level shifts in macrozooplankton may indicate basic changes in ocean productivity, it is not certain that this indicator will be monitored under GEM. This proposal is premature until GEM is further developed.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02604	Gear Selectivity in Trawl Surveys along the Northern Gulf of Alaska	W. Bechtol/ADFG	ADFG	New 1st yr. 2 yr. project	$52.1	$0.0	$15.0	$0.0

Project Abstract

This project will explore approaches to developing long-term monitoring techniques for forage fish populations in Cook Inlet, an area representative of ecosystem conditions and changes in the northern Gulf of Alaska. Time series data are available for two different trawl surveys conducted in Kachemak Bay in lower Cook Inlet. One survey series dates to the 1970's and uses a small-mesh trawl that catches species representative of the underlying forage base in this area. The second survey series, dating to 1990, uses a larger-mesh trawl fished closer to the bottom and catching substantially different species composition. Comparison of the catch composition time series from these two survey types will allow determination of gear selectivity between these trawls.

Chief Scientist's Recommendation

This proposal identifies an important issue, gear selectivity, but there is substantial disagreement among experts on the methodological problems associated with comparative selectivity studies. This suggests that the results from the study would not be definitive. Do not fund.

Executive Director's Recommendation

Do not fund. This project would compare small-mesh and large-mesh trawl surveys to determine relative catchabilities of these two bottom trawl designs in regard to monitoring techniques for forage fish. However, due to methodological concerns associated with comparative selectivity studies, funding is not recommended.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02612	Detecting and Understanding Marine-Terrestrial Linkages in the Kenai River Watershed	W. Hauser/ADFG	ADFG	New 1st yr. 1 yr. project	$44.6	$44.6	$0.0	$0.0

Project Abstract

This project will provide matching funds for a coordinator to serve a multidisciplinary team of agency-supported scientists that is designing a study of marine and terrestrial nutrient cycling in the Kenai River watershed. The oil spill curtailed commercial fishing on the river in 1989, causing changes in productivities of sockeye salmon and other species, in addition to allowing a massive input of marine nutrients born by the unharvested salmon. The watershed is also at some risk from anthropogenic activities including habitat degradation, increased utilization and invasive species. Studies on watersheds of the Pacific Northwest suggest there may be cascading impacts when marine derived nutrients normally supplied by salmon carcasses are diverted from an ecosystem. When nutrients normally supplied by salmon are withdrawn, productivity of the entire watershed is expected to be diminished.

Chief Scientist's Recommendation

This project will develop the basis for monitoring inputs of marine nutrients in watersheds adjacent to the Gulf of Alaska. Therefore, it should aid future GEM activities. The project has substantial scientific potential, as well as scientific support and financial participation by concerned agencies and organizations in the region. This is a community based monitoring effort with substantial community cost sharing. Fund revised proposal, which provides a more thorough explanation of the scientific framework and rationale for the project in relation to GEM.

Executive Director's Recommendation

Fund revised proposal, which provides a more thorough explanation of the scientific basis for the project and presents the scientific framework in the context of the GEM conceptual model. This project, which is the outgrowth of a multidisciplinary discussion group on the Kenai River watershed, is designed to increase understanding of food-web dynamics in the watershed and the role of marine derived nutrients in the ecosystem.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02644	Molecular Biomarkers as a New Technique for Assessing Physiological Contaminant Stress	G. Shigenaka/NOAA HAZMAT	NOAA	New 1st yr. 1 yr. project	$114.1	$0.0	$0.0	$0.0

Project Abstract	Chief Scientist's Recommendation	Executive Director's Recommendation
This project has two primary objectives: (a) a targeted evaluation/validation of new monitoring technology (based on the measurement of a series of molecular biomarkers) to assess extent and source of biological stress and (b) the linking of stress in mussels inhabiting small boat harbor areas in Prince William Sound and lower Cook Inlet to contaminant type (i.e., fuel oils or antifouling paint components). The monitoring tool has the potential for application beyond this specific setting (and particularly as a transitional bridge to GEM), but the work as proposed will provide useful information on the biological status of mussels residing in six small boat harbors in Prince William Sound and lower Cook Inlet.	This proposal would use state-of-the-art methods to detect effects of contaminants. However, the presentation of the measures proposed to detect contaminant stress provide little to justify the large list of markers or the means to evaluate changes in them. Do not fund.	Do not fund. The Chief Scientist raised technical concerns about this project, which would focus and refine validation of DMBS (Downs Molecular Biomarker System) analysis as a tool to detect effects of contaminants.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02648-BAA	Cost Effective Data Acquisition Using Adaptive Sampling and Combining Information Strategies	D. Dorsett/Baylor Univ.	NOAA	New 1st yr. 2 yr. project	$56.2	$0.0	$58.1	$0.0

Project Abstract	Chief Scientist's Recommendation	Executive Director's Recommendation
This project will analyze data acquired in a pilot study of adaptive sampling by FOCI in 1999 to provide information for designing adaptive sampling methods to be used in GEM. Detailed adaptive sampling methods will be documented to enhance cost effective methods of data collection. In a second phase, statistical methods of combining data from different sources will be determined and documented for further efficient data utilization.	The implementation of a statistically sound adaptive sampling protocol for much of the GEM research should be a top priority. An analysis of adaptive sampling that produces overall principles of how this method could be useful in GEM would be extremely valuable. The present proposal is too specifically focused to be useful for GEM, and lacks the methodological detail to be properly evaluated. Do not fund, but consider revised proposal in FY 03.	Do not fund. However, the proposer is encouraged to resubmit a proposal for consideration in FY 03 that addresses the Chief Scientist's concerns (with a focus more appropriate for GEM and additional methodological detail). In general, an analysis of adaptive sampling, in which the procedure for selecting sample sites and allocating sampling effort depends on data collected during the survey, and how this method could be useful in GEM, would be very worthwhile.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02674-BAA	Assessing Pigeon Guillemot Restoration Techniques	J. French/Pegasus Enterprises, G. Divoky/UAF	NOAA	New 1st yr. 2 yr. project	$42.6	$42.6		

Project Abstract

This project will monitor pigeon guillemot restoration projects initiated between 1998-2000. Censuses of Resurrection Bay to determine survivorship and breeding behavior of birds fledged from the Alaska SeaLife Center will be conducted and the occupancy and success of artificial nest sites erected at the Alaska SeaLife Center, Hat Island, North Beach, and Jackpot Island will be monitored. The characteristics of these sites, the nest boxes, and reproductive behaviors observed in the avian habitat at the Alaska SeaLife Center will be assessed to delimit the efficacy of nest boxes as a restoration or monitoring tool.

Chief Scientist's Recommendation

This is an interesting proposal from well-qualified investigators to do follow-up work on two past EVOS projects. It proposes to determine whether fledging of guillemots at the Alaska SeaLife Center and provision of artificial nest sites might lead to establishment of an enhanced pigeon guillemot population in Resurrection Bay. This proposal will monitor pigeon guillemots returning to Resurrection Bay and other sites, including evaluation of occupancy of various artificial nest sites, which will provide worthwhile performance monitoring of restoration actions. The other components of this project (objectives 3 and 4) seem less compelling, or best carried out in the context of a broader GEM effort in the future. Fund revised proposal, which reduces the project's scope to objectives 1 and 2 only.

Executive Director's Recommendation

Fund revised proposal, which reduces the project's scope to objectives 1 (survival and recruitment of captive raised birds) and 2 (association of pigeon guillemots with artificial nest boxes and social attraction arrays, including observation of nest boxes in the avian habitat at the Alaska SeaLife Center). This project will evaluate the effectiveness as a pigeon guillemot restoration technique of the 65 nest boxes installed under Project /327. Funds for FY 03 may be considered following a review of the FY 02 results. [Note: Funding of $17,800 for Alaska SeaLife Center bench fees for this project is currently included under Project 02350.]

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
GEM Transition: Tools to Improve Monitoring					$745.9	$386.0	$390.3	$17.1
02404	Testing Archival Tag Technology in Coho Salmon	J. Nielsen/USGS-BRD	DOI	Cont'd 2nd yr. 2 yr. project	$104.6	$104.6	$0.0	$0.0

Project Abstract

Archive tags with temperature and light-geolocation sensors will be monitored for post-smolt coho salmon in Cook Inlet. Light/location relationships specific to the Gulf of Alaska developed under Project 00478 will be applied in this study of movement and migration paths for coho salmon during maturation in ocean environments in Cook Inlet. Salmon for this study will be reared in captivity (at the Alaska Department of Fish and Game hatchery at Fort Richardson) to 1+ year of age (200-250mm) and released in Cook Inlet as part of the department's Ship Creek sport-fishing hatchery release. FY 01 includes pilot studies of tag retention, behavior, and growth for coho in captivity. Ship Creek coho will be tagged mid-May. A spring release experiment in the first year will be contingent on the successful implementation and retention of these tags. Surveys for early jack recoveries will be done at the Ship Creek weir and among sport fishers. Monitoring for adult tag recoveries will be done in the coho commercial fishery in Cook Inlet and the derby sport fishery on Ship Creek. Archive tagged fish will be used to document coho salmon use of marine habitats, migration routes, contribution to the sport fishery, and hatchery/wild interactions for salmon in Cook Inlet.

Chief Scientist's Recommendation

This is an excellent project whose results will provide important information for defining the geographic location of coho habitat and sampling the physical characteristics of the habitat. It is on track for accomplishing its objectives and is being managed by an excellent investigator. The studies of tag retention, behavior, and growth of captive juveniles are underway and the results are promising. Additional advertising to various portions of the community should be conducted to increase potential for tag returns. Fund.

Executive Director's Recommendation

Fund contingent on receipt of a description of the deployment procedure intended to insure against loss of data. In FY 01, the Trustee Council funded a pilot tag retention, behavior, and growth study to further test the development and application of archive tag technology, which has great promise for a variety of species. The pilot study has been completed, and a release experiment is already underway in FY 01. FY 02 would provide funding for continuation of the release experiment. The final report on this project will be submitted in FY 04, with all FY 03 and FY 04 costs being covered by the U.S. Geological Survey/Biological Resources Division (USGS-BRD). USGS-BRD is making a significant financial contribution to this project in FY 01 and FY 02 as well.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02434	Design of a Video System for Remotely Monitoring Seabirds at East Amatuli Island	A. Kettle/USFWS	DOI	New 1st yr. 2 yr. project	$4.3	$0.0	$1.1	$0.0

Project Abstract

During the 1990's, rough seas at East Amatuli Island have occasionally blocked access to cliff plots where seabird breeding and population size data are collected; it is possible that in the future weather patterns could compromise datasets. Recently developed technology makes it possible to transmit video images of the cliff plots to the East Amatuli field camp. This could augment field observations and allow safe data collection to continue through periods of rough seas. This project will design requirements for such a system, research and price available components, and determine the price for contractual system design and assembly.

Chief Scientist's Recommendation

This project would write specifications for equipment for remote monitoring of bird colonies on East Amatuli Island. Although the project's intended purpose of decreasing lost data on an injured resource is a worthy purpose in terms of restoration, this project would not reach that objective in FY 02. Do not fund.

Executive Director's Recommendation

Do not fund. The Trustee Council funded a remote video setup on East Amatuli Island in FY 99 (Project 99434) to transmit images from the seabird colonies to the Pratt Museum in Homer. This project would be the first step in establishing a similar system that would transmit images to the East Amatuli field camp and be designed solely for scientific monitoring, not as a museum exhibit. However, the funds requested are for a minimal amount of staff time to research and price the design of such a system--it is unclear where funds for puchase, installation, and operation of the system would come from. Researching the system might be an appropriate contribution for the U.S. Fish and Wildlife Service to make to this endeavor.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02584	Evaluation of Airborne Remote Sensing Tools for GEM Monitoring	E. Brown/UAF, J. Churnside/NOAA	ADFG	New 1st yr. 3 yr. project	$118.4	$75.0	$240.0	

Project Abstract

This project will evaluate airborne remote sensing tools for GEM monitoring, including a biological/ecological interpretation of the data collected. The instrument package consists of (a) a pulsed LIDAR (Light Detection and Ranging) to map subsurface biological features day to a maximum of 50 m, (b) an infrared radiometer to map SST (sea surface temperature) day (similar to AVHRR, Advanced Very High Resolution Radiometer), (c) two three-chip digital video systems to map ocean color (chlorophyll), birds, mammals, surface fish schools, and ocean frontal structure, and (d) an infrared digital video to map birds and mammals at night. The project will use shipboard and buoy data for validation and interpretation of remote sensed data. [Note: The FY 04 cost (year 3 of the project) has not been provided.]

Chief Scientist's Recommendation

The development of monitoring tools using LIDAR (Light Detection and Ranging) or other remote sensing techniques could be very valuable for GEM. The proposal is very ambitious and broad-ranging, and it seems unlikely that all project objectives can be achieved. Development work for remote sensing techniques is frequently difficult and expensive. A more limited set of objectives focused on proof-of-concept might be appropriate. Defer pending review of a revised proposal that addresses proof-of-concept only, assessment of support from other agencies, and delivery of past due reports by the principal investigator (Brown).

Executive Director's Recommendation

Defer decision on funding this project to December, pending review of a revised Detailed Project Description and budget that (a) reduce the project's focus to proof-of-concept (roughly $75,000) and (b) include more information on financial support from other entities. If funded, funding will be contingent on (a) receipt of a description of the deployment procedure intended to insure against loss of data and (b) submittal of overdue report (Project 99375). This project would explore airborne remote sensing instrumentation as a monitoring tool for GEM. The *FY 02 Invitation* invited proposals to develop cost-effective data acquisition technologies that could be useful to GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02614	Monitoring Program for Near-Surface Temperature, Salinity, and Fluorescence in the Northern Pacific Ocean	S. Okkonen/UAF	ADFG	New 1st yr. 2 yr. project	$38.2	$38.2	$17.1	$17.1

Project Abstract

This project will use a thermosalinograph and fluorometer, to be installed on a crude oil tanker, to acquire continuous, long-term measurements of the near-surface temperature, salinity, and fluorescence fields along the tanker route between Valdez, Alaska and Long Beach, California.

Chief Scientist's Recommendation

This is an innovative proposal to determine the feasibility of taking frequent surface ocean measurements of temperature, salinity, and fluorescence on oil tankers traveling from Alaska to California. This would provide a stream of data on ocean conditions in Alaskan waters that would be extremely useful to GEM and supplement data taken by satellites and from fixed buoys on the GAK-1 line and data from NE GLOBEC (Global Climate Change) transects. Fund.

Executive Director's Recommendation

Fund contingent on receipt of a description of the deployment procedure intended to insure against loss of data. This project will install a thermosalinograph and fluorometer on a crude oil tanker traveling between Valdez and Long Beach. Vessels of opportunity such as this are a cost-effective method that may be useful to GEM, and proposals to place oceanographic instrumentation packages on ships of opportunity were specifically invited in the *FY 02 Invitation*. The data collected by this project on ocean conditions in Alaskan waters will be extremely useful to GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02618-BAA	Measurements of Tide Rip Front Variability in Cook Inlet	S. Saupe/CIRCAC	NOAA	New 1st yr. 2 yr. project	$11.7	$0.0	$3.7	$0.0

Project Abstract

This project will use a vessel-mounted thermosalinograph to acquire long-term measurements of near-surface temperature and salinity to identify variability in the location and intensity of tide rip fronts in Cook Inlet.

Chief Scientist's Recommendation

The proposal does not make a compelling link to restoration objectives, as spill response is not within the mission of the Trustee Council. While the program is fairly inexpensive, there are questions about the technical feasibility and potential biasing of the data. Do not fund.

Executive Director's Recommendation

Do not fund. This project would purchase a thermosalinograph to assist Cook Inlet Spill Prevention and Response, Inc. (CISPRI) in identifying variability of tide rip fronts in Cook Inlet in order to improve spill prevention and response capabilities. Trustee Council funds cannot be used for preparation for future spills. In addition, the Chief Scientist has raised questions about the project's technical feasibility and potential biasing of the data. However, the proposer should continue to explore with Council staff possible projects and ideas that might be mutually beneficial in terms of CIRCAC's (Cook Inlet Regional Citizens' Advisory Council) interest in environmental monitoring and GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02624-BAA	A CPR-Based Plankton Survey Using Ships of Opportunity to Monitor the Gulf of Alaska	S. Batten/SAHFOS, D. Welch/DFOC	NOAA	New 1st yr. 1 yr. project	$133.4	$133.4	$0.0	$0.0

Project Abstract

This project presents the rationale for developing a plankton monitoring program for the Gulf of Alaska using ships of opportunity. Plankton are a critical link in the marine food chain whose dynamics are poorly understood, but respond rapidly and unambiguously to climate change and form the link between changes in the atmosphere and valuable upper trophic level populations, such as salmon, herring, shrimp, and groundfish. The proposal reviews the evidence that many of the most valuable marine resources in the Gulf of Alaska are strongly influenced by changes in ocean climate. Ships of opportunity are a cost effective platform for large scale monitoring and this project will build on recent experience gained with CPR (continuous plankton recorders) in the North Pacific to prepare for GEM.

Chief Scientist's Recommendation

This kind of program--instrumented ships of opportunity--will likely be the way to establish a long-term oceanic monitoring program in the Gulf of Alaska. The largest tankers are not hindered much by the weather, so rather continuous sampling can be expected. Questions of spatial and temporal coverage must be evaluated, however, since the understanding of how the plankton is distributed will only be as good as the sampling design permits. Fund, but defer until December in order to assess the availability of cost sharing with the North Pacific Research Board (NPRB).

Executive Director's Recommendation

Defer decision on funding this project to December, pending more information on the availability of funds for this purpose from the North Pacific Research Board. If funded, funding will be contingent on (a) receipt of a description of the deployment procedure intended to insure against loss of data and (b) resolution of budget questions. This project would fund continuation of a continuous plankton recorder (CPR) on an oil tanker traveling from Valdez to Long Beach and on a second vessel along a Vancouver, B.C. to Kamchatka monitoring line. The Valdez to Long Beach recorder was funded in FY 00 and FY 01 by the North Pacific Marine Research fund. Vessels of opportunity such as this are a cost-effective method that may be useful to GEM, and proposals to place oceanographic instrumentation packages on ships of opportunity were specifically invited in the *FY 02 Invitation.*

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02627-BAA	A Symbiotic Acoustic Signal Processor to Increase Stock Assessment Effort	J. Dawson/BioSonics, Inc.	NOAA	New 1st yr. 1 yr. project	$171.0	$0.0	$0.0	$0.0

Project Abstract

This project will develop a Symbiotic Acoustic Signal Processor (SASP) system, consisting of a high resolution digital sonar receiver that attaches to an existing shipboard echo sounder and routes the output over an Ethernet connection to displays, storage, and processing systems. This system provides the capability to store geo-referenced raw digital acoustic data in an established scientific format to PC hard disk. The data collected and analyzed using this system can determine abundance and distribution of stocks within the sampled areas. The design philosophy provides a low-cost system that is extremely simple for a skipper to operate, does not require dry-dock installation or towing of an underwater transducer sled, and does not effect the operation of the currently installed echo sounder.

Chief Scientist's Recommendation

This proposal requests funds to help develop and apply state-of-the-art techniques for real-time, species-specific estimates of fish biomass using ships of opportunity. GEM may develop a ships-of-opportunity program to collect a variety of different observations. This may well include hydroacoustic data. However, the plans for GEM at this time preclude development of technology such as that proposed. Do not fund.

Executive Director's Recommendation

Do not fund. This project would design, manufacture, and test a symbiotic sonar receiver that attaches to echo sounders installed on commercial fishing vessels (ships-of-opportunity) for collecting real-time estimates of fish biomass. Proposals to develop cost-effective data acquisition technologies were invited in the *FY 02 Invitation.* However, at this point in the development of GEM, it is premature to take on development of technology such as this.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02640	High Frequency Surface Wave Radar Test in Prince William Sound	A. Kotlarov/Alaska Marine Technology Corp.	NOAA	New 1st yr. 2 yr. project	$129.5	$0.0	$128.4	$0.0

Project Abstract

This project will analyze surface currents in Prince William Sound with a portable short-range, high-frequency surface wave radar system. Use of this advanced technology will increase knowledge and understanding of the overall distribution of currents in the sound, and will add significantly to existing information about the sound's circulation obtained from models such as those developed by Wang, Deleersnijder, Mooser and others. Once deployed and operating, this system will provide real-time and archived data about ocean surface currents in the sound. Observations will include current speed, current direction, diversion flow, and upwelling dynamics. The complete system will consist of two radars that are capable of measuring current vectors in real time out to a distance of fifty miles.

Chief Scientist's Recommendation

While new radar techniques such as this might be useful, until a clearer need for these data is demonstrated the linkage of this proposal to restoration objectives is weak. There are many technical issues that are not addressed in the proposal. Do not fund.

Executive Director's Recommendation

Do not fund. This proposal, which would deploy a short-range, high-frequency surface wave radar system to provide data about ocean surface currents in Prince William Sound, does not demonstrate the need for these data. In addition, the Chief Scientist has expressed concern that the proposal does not address a number of technical issues.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02671-BAA	Coordinating Volunteer Vessels of Opportunity to Collect Oceanographic Data in Kachemak Bay and Lower Cook Inlet	D. Stram, C. Schoch/Kachemak Bay NERR	ADFG	New 1st yr. 1 yr. project	$34.8	$34.8	$0.0	$0.0

Project Abstract

Cook Inlet Keeper and the Kachemak Bay Research Reserve will organize a network database of local community volunteers for the purpose of collecting oceanographic data from regional ships of opportunity. An outreach program will be undertaken to identify and construct a database of private and commercial vessels making frequent trips in the Kachemak Bay, lower Cook Inlet, and Gulf of Alaska regions. A thermosalinograph, installed on a vessel at the Kachemak Bay Research Reserve, will be used to clarify regions for future data collection. These data will also be correlated with existing stationary sensors and volunteer-monitoring projects to expand spatial and temporal knowledge of water quality and mixing patterns and their relationship to the dispersal of larvae and pollutants in the region.

Chief Scientist's Recommendation

The work proposed could be a pioneering effort in community involvement in scientific data acquisition. Methods will be developed that will allow community-based efforts to fill important gaps. A revised proposal has been developed that deemphasizes data collection and analysis in the initiation of the project and focuses on (a) developing logistics for a network of local ships of opportunity, (b) participation of the broader oceanographic community in identifying the types of variables and locations for sampling, and (c) implementation of QA/QC procedures for data collection and geolocation. The principal investigators should also develop a prototype plan for allocating volunteer sampling efforts so that efforts are allocated to capture spatial and temporal ocean variability. Fund.

Executive Director's Recommendation

Fund revised proposal, which deemphasizes data collection and analysis and focuses on organizing a network database of local community volunteers for the purpose of collecting oceanographic data from regional ships of opportunity. As recommended by the Chief Scientist, the principal investigators should also develop a prototype plan for allocating volunteer sampling efforts so that efforts are allocated to capture spatial and temporal ocean variability. Vessels of opportunity are a cost-effective data collection method that may be useful to GEM, and proposals related to ships of opportunity were specifically invited in the *FY 02 Invitation*. Methods developed under this project should be transferable to other regions of the spill area, such as Prince William Sound.

GEM Transition: Synthesis & Retrospective Analysis					$1,100.6	$471.2	$917.8	$46.2
02578	The Marine Macrofauna of Prince William Sound: An Annotated List	N. Foster, H. Feder	NOAA	New 1st yr. 1 yr. project	$38.3	$35.0	$0.0	$0.0

Project Abstract

Data sets that present basic taxonomic and biogeographic information at the species level for 1,645 animal species from Prince William Sound have been compiled as part of research on potential introductions of nonindigenous species. This project will make this important information available to a wider group of users, including EVOS stakeholders.

Chief Scientist's Recommendation

I recommend careful consideration of this proposal. Its priority ranking may be high enough to justify its support for FY 02. It is worthy but not an essential piece of work. Fund lower priority.

Executive Director's Recommendation

Defer decision on funding this project to December, pending availability of funds. If funded, funding will be contingent on resolution of budget issues. This project would produce a publication on the marine macrofauna of Prince William Sound, using data compiled through other research on non-indigenous species in the sound.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02597-BAA	Ocean Color Time Series of Prince William Sound	S. Pegau/ OSU	NOAA	New 1st yr. 1 yr. project	$28.5	$0.0	$0.0	$0.0

Project Abstract

This project will develop a time series of chlorophyll concentrations and other ocean color products for general use. The time series will include full resolution images of the coastal waters of Alaska and Prince William Sound in particular. SeaWiFS (Sea-viewing Wide Field-of-view Sensor) data collected at University of Alaska-Fairbanks will be processed with the current state of the art algorithms. The data will be mapped into regional areas at 1 km resolution. The possibility of adding CZCS (Coastal Zone Colour Scanner) and OCTS (Ocean Color and Temperature Scanner) data to increase the temporal extent of the time series will be examined. This data set will allow investigators to examine how the base of the food chain (phytoplankton) has varied monthly, seasonally, and annually during the life of these missions.

Chief Scientist's Recommendation

This is a good proposal in both methods and objectives, but it does not carry the burden of proof regarding what kinds of research would be enabled by having the SeaWiFS (Sea-viewing Wide Field-of-view Sensor) data on a finer spatial resolution (1 km vs. the 10 km currently available). The proposal is poorly coordinated with regional scientists and programs, and premature in terms of GEM implementation. Do not fund.

Executive Director's Recommendation

Do not fund. This project would create and maintain a time-series database of 1-km resolution SeaWiFS ocean color products for the Gulf of Alaska. The Chief Scientist has questioned whether this degree of resolution is necessary. In addition, the project is premature in terms of GEM implementation.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02600	Synthesis of the Ecological Findings from the EVOS Damage Assessment and Restoration Programs, 1989-2001	R. Spies/EVOS Chief Scientist, et al	ADNR	New 1st yr. 2 yr. project	$151.6	$151.6	$307.4	

Project Abstract

This project will synthesize the significant results from 12 years of post-spill study in the EVOS damage assessment and restoration programs as they relate to anthropogenic and natural forcing factors influencing the northern Gulf of Alaska. The results of the synthesis will be incorporated into a series of interrelated manuscripts that will either be submitted to a journal for publication as a whole volume, or to a publisher as a book. This effort will be one of the major products of the EVOS restoration program and help set the foundation for GEM.

Chief Scientist's Recommendation

Proposal will not be reviewed by Chief Scientist.

Executive Director's Recommendation

Defer decision on funding this project to December, pending completion of review. There is a need to integrate what has been learned from more than a decade's worth of science following the oil spill. Such a synthesis could fulfill at least two purposes: (a) inform the public about the EVOS legacy in a scientifically rigorous yet readable volume and (b) provide a foundation for GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02622	Digital Maps from Existing Seasonal Environmental Sensitive Area Maps: Cook Inlet/ Kenai Peninsula	J. Whitney/NOAA	NOAA	New 1st yr. 1 yr. project	$36.6	$36.6	$0.0	$0.0

Project Abstract

A series of national standardized digital map products will be produced form the existing seasonal Environmental Sensitivity Index (ESI) maps for Cook Inlet/ Kenai Peninsula made by the National Oceanic and Atmospheric Administration (NOAA) in 1994. A four map seasonal series was originally developed for Cook Inlet by the NOAA Hazardous Materials Response and Assessment Division in the ArcInfo digital format with the output and distribution primarily being poster maps at a scale of 1:450,000. Since then, combined with greater demand for digital products, NOAA's digital ESI products have greatly expanded. This project will transform the existing Cook Inlet/Kenai Peninsula digital data into a four-tiered nationally standardized set of digital map products with the deliverable being 100 CDs. These will be the same products that were recently provided for Prince William Sound under Project 99368.

Chief Scientist's Recommendation

This project would transform the existing Cook Inlet/Kenai Peninsula digital data into a four-tiered nationally standardized set of digital map products with the deliverable being 100 CDs. A similar product was provided by the contractor for Prince William Sound under Project 99368/Prince William Sound Environmental Sensitivity Index (ESI) Maps. The utility of having the maps on CDs would expand their accessibility, but there are no immediate use or user groups identified. Further there is no cost sharing provided by the agency. Fund lower priority.

Executive Director's Recommendation

Defer decision on funding this project to December, pending availability of funding. If funded, funding would be contingent on (a) consideration of creating the maps on the World Wide Web rather than on CD and (b) addition of other reviewers, e.g., U.S. Forest Service and the Oil Spill Recovery Institute. This project would convert the existing Cook Inlet Environmental Sensitivity Index (ESI) seasonal summary maps to the 1998 national standardized format (Full GIS, Desktop Mapping, Free ESI Viewer, and PDF ESI Navigator) in an effort to make the maps more accessible.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02636-BAA	Ecosystem Recovery Through a Partnership with the Spill-Impacted Communities	K. Adams, B. Perrine, R. Mullins/Cordova	NOAA	New 1st yr. 2 yr. project	$360.0	$50.0	$334.2	

Project Abstract

The goal of securing and sustaining the recovery of the marine system is a first priority for the Trustee Council as well as for the spill-impacted region. Given the successes of the Council's Restoration Plan, that goal is within reach. The economies and the communities of the spill-impacted region are the natural partners for realizing the goal. In this regard, commercial fishing has the involvement, resources, and motivation--through long term financial positions and committed financial risks--to be one of the most effective partners. This project will develop a plan and demonstrate that a partnership can accomplish significantly more toward our common goal than is possible through the same investments expended independently.

Chief Scientist's Recommendation

As I understand this proposal, it would provide the fishing community's perspective on the scientific accomplishments of the restoration program, and explore how to incorporate new scientific results into management practices. A "fishing industry" view of EVOS research and results, and their application, would be an interesting and valuable contribution. This project could also build a partnership with professional fishers, which will be important in the development of GEM. The proposal would benefit from more focus and coordination with other synthesis efforts. Defer pending receipt and evaluation of revised, more focused proposal at a reduced cost.

Executive Director's Recommendation

Defer decision on funding this project to December, pending clarification of the project's objectives and cost. The EVOS program could benefit from the commercial fishing community's perspective on restoration results and interaction with fishers on how to incorporate the results into fisheries management practices. In addition, the project could form a foundation for working with Prince William Sound fishers as GEM develops. The Public Advisory Group has suggested that one aspect of a revised proposal might be preliminary work on a vessels-of-opportunity program for Prince William Sound (for example, identification of fishing and other vessels that make frequent trips in the sound).

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02649	Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years	B. Finney/UAF	ADFG	New 1st yr. 2 yr. project	$88.1	$88.1	$28.2	$28.2

Project Abstract

This project will reconstruct the last 2,000 years of changes in sockeye salmon abundance in Eshamy Lake (Prince William Sound) and Upper Russian Lake (Kenai River watershed) by analyzing ^{15}N in lake sediments. This new data will be synthesized with ongoing studies at Karluk Lake (Kodiak Island). The research question is: What is the normal variability in sockeye salmon populations in the Gulf of Alaska? This research will contribute to development of the GEM program by providing a historical perspective on present conditions and by developing new hypotheses about the climatic causes of population fluctuations in Gulf of Alaska salmon. Work at Delight and Desire lakes on the outer Kenai Peninsula coast will also be conducted, as recommended by the Trustee Council's Public Advisory Group.

Chief Scientist's Recommendation

This proposal will use stable nitrogen isotope ratios to reconstruct the historical variation in contributions of marine nitrogen to several lake systems in the spill area: Eshamy Lake in Prince William Sound, Upper Russian Lake on the Kenai Peninsula, Karluk Lake on Kodiak Island, and Delight and Desire lakes on the outer Kenai Peninsula coast. Past work by these investigators has demonstrated that fluctuations in sockeye salmon runs to lakes are approximated by the variability in the nitrogen isotope ratios in sediments deposited at the time of salmon returns. The work of Francis and Hare has clearly shown that salmon populations fluctuate in concordance with the Pacific Decadal Oscillation. This relationship then presents the retrospective tool needed to provide a historical context for understanding how the marine ecosystem is likely to change naturally in the future under various climatic conditions. This work will supplement independent ongoing work of a similar nature in other local lake systems and thereby provide a reliable regional picture of fluctuations. Fund.

Executive Director's Recommendation

Fund, including work recommended by the Public Advisory Group at Delight and Desire lakes on the outer Kenai Peninsula coast, contingent on submittal and approval of a revised Detailed Project Description and budget that reflect this new objective. This project will conduct a retrospective study of sockeye abundance in certain lakes in the spill region and develop hypotheses about how changes in the atmosphere/ocean system affect salmon populations. It is responsive to the *FY 02 Invitation*, which invited proposals to analyze and synthesize existing data sets and historical records.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02656	Retrospective Analysis of Nearshore Marine Communities Based on Analysis of Archaeological Material and Isotopes	G. Irvine/USGS, J. Schaaf/NPS	DOI	New 1st yr. 2 yr. project	$109.9	$109.9	$18.0	$18.0

Project Abstract

This project will investigate long-term (6,300 year) patterns of productivity and relative species abundances in nearshore, intertidal communities via retrospective analyses. These analyses will focus on excavated midden remains of very rich, well-dated archaeological sites along the Katmai National Park and Preserve coast. Changes in nearshore marine communities will be assessed through examination of relative species abundances, size-frequency analysis, and other indicators of habitat changes. Isotopic analysis of shells will provided an assessment of long-term productivity patterns in the nearshore marine environment as related to major periods of climate change.

Chief Scientist's Recommendation

This project has great potential to examine one measure of marine productivity over the past 6,000 years and to compare this data with recently published work on sockeye salmon populations over a similar period. The principal investigators are well qualified and have written a creditable proposal. Fund revised proposal, which successfully addresses the issues of interpretation of stratigraphy raised by the reviewers, and provides more information on the credentials and publication record of the principal investigators in paleoclimatology and paleoceanographic studies.

Executive Director's Recommendation

Fund revised proposal, which addresses the Chief Scientist's concerns (interpretation of stratigraphy and investigators' credentials in paleoclimatology and paleoceanographic studies). This project is designed to improve understanding of long-term change in nearshore marine communities and investigate the relationship between productivity and climate. It is responsive to the *FY 02 Invitation*, which invited proposals to analyze and synthesize existing data sets and historical records.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02664	Retrospective Analysis of 30 Years of Seabird Distribution and Diet Data	J. Piatt/USGS	DOI	New 1st yr. 3 yr. project	$287.6	$0.0	$230.0	$0.0

Project Abstract

Seabirds are excellent indicators of change in the marine environment. An enormous amount of data on the abundance, distribution and dietary habitats of seabirds in Alaska have been gathered at great expense over the past 30 years, but most of it has not been analyzed beyond the scale at which it was gathered. This project will compile some historical seabird data sets and create accessible data archives as a tool for assessing past and future human impacts on seabirds populations, a foundation for future studies, and to test some basic hypotheses about the effects of regime shifts on diet and distribution of seabirds in Alaska. [Note: This project also requested funding ($120,000) for FY 04.]

Chief Scientist's Recommendation

Since OCSEAP (Outer Continental Shelf Environmental Assessment Program) in the 1970s, there has been an enormous amount of data gathered on marine birds and diets. There is a need to integrate these databases and to analyze them to learn about the relationships among seabird numbers and distributions, diets, and oceanographic parameters and features. Such retrospective analysis may prove to be very important in the development of GEM, but is premature until the synthesis and research components of GEM are more well defined. The investigators for this project are superb, but the cost is high, and there are several administrative questions about the budget. Do not fund as proposed.

Executive Director's Recommendation

Do not fund. This proposal, which has broad significance for the Bering and Chukchi seas as well as for the northern Gulf of Alaska, would have been better received if it had significant cost-sharing from other entities. One future possibility is the North Pacific Research Board. In addition, the principal investigator has two overdue reports (00163/APEX chapter and 00510/seabird monitoring protocols). This is a very expensive project, and some aspects of the budget are unclear. This project would create two databases--one on seabird diet and one on pelagic distribution--through compilation of existing data, and perform retrospective analyses of relationships between seabirds and various oceanographic parameters. The *FY 02 Invitation* invited proposals to analyze and synthesize existing data sets and historical records, but this proposal may be premature until the synthesis and research components of GEM are more well defined.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
GEM Transition: Long-Term Monitoring					$1,619.5	$666.1	$93.9	$11.6
02210	Prince William Sound/Lower Cook Inlet Youth Area Watch	R. DeLorenzo/Chugach School District	ADFG	Cont'd 7th yr.	$106.1	$106.1	$0.0	

Project Abstract

This project links students in the oil spill impacted area with research and monitoring projects funded by the Trustee Council. The project involves students in the restoration process and provides these individuals the skills to participate in restoration now and in the future. Youth conduct research identified and delegated by principal investigators who have indicated interest in working with students. Youth Area Watch fosters long-term commitment to the goals set out in the restoration plan and is a positive community investment in that process. Participating communities in FY 02 will be Tatitlek, Chenega Bay, Cordova, Nanwalek, Port Graham, Seldovia, Seward, Valdez, and Whittier.

Chief Scientist's Recommendation

The Youth Area Watch has been a popular and successful project, probably the most successful of the EVOS projects in terms of encouraging and facilitating positive participation in the affected communities. The proposers seek what would be a seventh year of funding for this project. However, they have done a good job of obtaining supplemental or alternative funding and are cognizant of the need to continue to seek such funds as the restoration program moves toward implementation of GEM. The future of the project remains unclear. The proposal would be strengthened by giving more attention to the value of the data gathered by the young people and to the evaluations of participating investigators. However, this is a strong and successful effort, and it should continue. Fund.

Executive Director's Recommendation

Fund, including funding increment ($9,700) for teacher participation in JASON. JASON is a nonprofit organization dedicated to education in the area of environmental science and research. Its 2002 expedition "Frozen Worlds" will take place in Southcentral Alaska, and will include curriculum development and teacher training. In general, Youth Area Watch involves local youth in restoration projects. In FY 02, youth in Chenega Bay, Cordova, Nanwalek, Port Graham, Seldovia, Seward, Tatitlek, Valdez, and Whittier will participate. The Trustee Council's contribution to this project has declined each year since the project's inception, as the Chugach School District has obtained funds from other sources to sustain the program. FY 02 was expected to be the final year of Council support, but this might be the type of community effort that is appropriate under GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02340	Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem	T. Weingartner/ UAF	ADFG	Cont'd 5th yr.	$77.8	$77.8		

Project Abstract

Interannual variations in temperature, salinity, and their vertical distribution on the northern Gulf of Alaska shelf reflect environmental changes that might affect this marine ecosystem. This variability needs to be quantified and understood based on extended time series such as the 30-year record at hydrographic station GAK1 near Seward. This project maintains this time series and will continue to quantify the variability and understand the sources of it. It will also begin to document interannual variations in near-surface (upper 10 m) stratification and the timing of the spring bloom on the inner shelf. The data and associated analyses are suggested as being an important component to the development of the GEM program.

Chief Scientist's Recommendation

The results of this project are key to GEM implementation. Further analysis of data from this project promises to reveal important relationships that would be key to monitoring the dynamics of the Alaska Coastal Current. The principal investigator proposes to do data analysis and write a manuscript for a peer reviewed journal in FY 02, which is highly desirable. This project should be continued in FY 02 with the following objectives: (a) produce annual report on FY 01 results, (b) prepare manuscript, and (c) continue gathering data. Fund revised proposal, which contains these objectives.

Executive Director's Recommendation

Fund revised proposal, which provides for continued Trustee Council support of hydrographic station GAK1 and the accompanying retrospective analyses of the station's data record, contingent on receipt of a description of the deployment procedure intended to insure against loss of data. GAK1 provides a long-term data set that allows characterization of the Alaska Coastal Current, which is essential to understanding climatological forcing of productivity and will be important for GEM.

Proj. No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02552-BAA	Exchange Between Prince William Sound and the Gulf of Alaska	S. Vaughan/PWSSC	NOAA	Cont'd 3rd yr. 3 yr. project	$102.5	$102.5	$0.0	$0.0

Project Abstract

One of the least understood physical processes that influence the biological components of Prince William Sound is the exchange between the northern Gulf of Alaska and Prince William Sound. This project will document the interannual variability in water mass exchange between the sound and the adjacent northern Gulf of Alaska at Hinchinbrook Entrance, and identify mechanisms governing this exchange. The project will deploy an upward looking ADCP (Acoustic Doppler Current Profiler) mooring in Hinchinbrook Entrance to create time series of velocities spanning three years. The mooring will be equipped with a CTD (conductivity temperature versus depth) to create a time series of deep temperature and salinity. To identify the dominant factors that govern Prince William Sound/Gulf of Alaska exchange, the mooring velocity and deep temperature/salinity time series will be combined with meteorological and physical data collected under other research programs already in progress.

Chief Scientist's Recommendation

Fixed instrumentation in Hinchinbrook Entrance is key to understanding the circulation and productivity of Prince William Sound and the Alaska Coastal Current. The Trustee Council has funded this project after the end of SEA (Sound Ecosystem Assessment, Project /320) in order to provide a continuing record. It is recognized that the single mooring has serious limitations for characterizing the exchange between the Alaska Coastal Current and the sound. Key to the limitations has been lack of summer/fall data due to battery-life limitations. Additionally, the upper forty-five meters of the water column are not sampled by the ADCP (Acoustic Doppler Current Profiler). The principal investigator was to pursue other sources of funds to address these limitations but additional funding has not been identified. Furthermore, there are overdue reports and manuscripts and no published papers over the past five years. Defer decision until above issues can be resolved.

Executive Director's Recommendation

Defer decision on funding this project to December, pending satisfactory resolution of the technical issues raised by the Chief Scientist and further review of the principal investigator's publication record. If funded, funding will be contingent on (a) resolution of budget questions, (b) receipt of a description of the deployment procedure intended to insure against loss of data, and (c) submittal of the overdue report on Project 00552. This project has continued data gathering and analysis from the Hinchinbrook Entrance buoy that was begun under SEA (Sound Ecosystem Assessment, Project /320). Although a buoy at Hinchinbrook Entrance is expected to be an important component of GEM, the Chief Scientist has identified a number of concerns with project implementation.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02561	Evaluating the Feasibility of Developing a Community- Based Forage Fish Sampling Project for GEM	D. Roseneau/USFWS	DOI	New 1st yr. 2 yr. project	$54.3	$54.3	$11.6	$11.6

Project Abstract

This project is based on the recently completed five-year pilot study, conducted as part of APEX (Alaska Predator Ecosystem Experiment, Project /163), that used stomach contents from sport-caught halibut to sample forage fish populations. The project will monitor long-term trends in forage fish populations in several regions of the spill area during GEM. The project will provide information to help assess and understand the types and levels of community participation that may be available for long-term forage fish monitoring studies. Also, if project results are favorable, the information can be used to begin designing cost-effective, community-based forage fish monitoring studies to track long-term trends in capelin and sand lance stocks in the Kachemak Bay/lower Cook Inlet, Resurrection Bay, Kodiak Island, and Prince William Sound regions.

Chief Scientist's Recommendation

This is an innovative approach to a difficult problem of assessing forage fish abundance over large temporal and spatial scales. The work would also make a strong contribution to understanding the feasibility of community based sampling programs, an important part of GEM transition. The principal investigator has an excellent record with the Trustee Council. Fund.

Executive Director's Recommendation

Fund. This project, which will visit 11 spill-area communities to explore involving local residents in long-term forage fish monitoring studies, builds on work successfully begun under APEX (Alaska Predator Ecosystem Experiment, Project /163). It will contribute to understanding the feasibility of community-based sampling programs in general, and therefore is an important part of GEM transition. The principal investigator's visits to communities should be coordinated with the Trustee Council's Community Development Director (Project /052). It should be noted that the Council's interest in this project in FY 02 is not in the particular data that might be gathered relevant to forage fish, but in the techniques and strategy that might be developed in regard to designing a community involvement component for GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02589-BAA	PWSRCAC - EVOS Long Term Environmental Monitoring Program	J. Devens/ PWSRCAC	NOAA	New 1st yr.	$233.3	$0.0		$0.0

Project Abstract

This project will provide essential long-term baseline measurements of hydrocarbon levels and sources at program sites within areas of Prince William Sound, Kenai Peninsula, Kodiak, and Gulf of Alaska. The objective is to provide a more comprehensive program for the collection of baseline data in subtidal sediments and mussel tissue that can be used to determine impacts of oil sources on the ecosystem. This project will provide an improved link to recovery status and greater efficiency in hydrocarbon sampling and analysis that has been ongoing since 1993 under the auspices of the Prince William Sound Regional Citizens Advisory Council (PWSRCAC).

Chief Scientist's Recommendation

The partnership proposed in this project may make sense as we move into GEM. However, the proposal is premature because the scope of GEM activities (ecosystem components to be measured, contaminants of interest, where to measure and when) has not been defined. In addition, there are questions of cost effectiveness, integration of collection activities with other GEM components, whether annual collections are required, and the ultimate questions to be addressed by the monitoring. Do not fund.

Executive Director's Recommendation

Do not fund. This project would expand the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) program of long-term sampling of hydrocarbon levels to additional sites and from mussels only to sediments also. While a partnership with the PWSRCAC may be desirable under GEM, this proposal is premature until GEM is further developed.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02603	Implementation of an Ocean Circulation Model: A Transition from SEA to GEM	J. Wang/UAF	ADFG	New 1st yr. 1 yr. project	$73.2	$66.4	$0.0	$0.0

Project Abstract	Chief Scientist's Recommendation	Executive Director's Recommendation
This project will establish a 3-D ocean circulation model in the Gulf of Alaska to lay down a foundation for GEM in order to couple this model to a hydrological model and a biological model. This model will cover the entire gulf, including Prince William Sound and Cook Inlet. The horizontal resolution of this model is 4'x2' minutes (about 3.7km at 60"N). This model will be forced by tides, the Alaska Current inflow/outflow, freshwater discharge, and wind stress derived from the National Center for Environmental Prediction.	This proposal is premature in that it is trying to establish a GEM circulation model. If GEM is to have an overall physical model of the system, this needs to be established with wider representation from the oceanographic and climatological communities. The model proposed here may or may not be the optimal modeling approach for the long run. A careful evaluation of possible modeling options should be undertaken prior to commencing with the funding of any physical/biological system model. Defer until ocean modeling workshop is held.	Defer decision on funding this project to December, pending a GEM modeling workshop, tentatively scheduled for October 2001. If funded, funding would be contingent on a revised budget for a slightly reduced amount. The project would expand the Prince William Sound circulation model--developed under SEA (Sound Ecosystem Assessment, Project /320) and continued under Project 01389/3-D Ocean State Simulations--to the Gulf of Alaska. Before a decision is made on this project, a thorough evaluation of possible modeling options should be undertaken through a process involving wide representation from the oceanographic and climatological communities. The October workshop will be designed to do this.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02609	Long-Term Temperature/Salinity Monitoring Within the Alaska Coastal Current	T. Weingartner/UAF	ADFG	New 1st yr. 2 yr. project	$59.8	$0.0	$15.5	$0.0

Project Abstract	Chief Scientist's Recommendation	Executive Director's Recommendation
Interannual variations in temperature, salinity, and their vertical distribution on the northern Gulf of Alaska shelf reflect environmental changes that might affect this marine ecosystem. This variability needs to be quantified and understood based on extended time series such as the 30-year record at hydrographic station GAK1 near Seward. This project maintains this time series and will continue to quantify the variability and understand the sources of it. It will also begin to document interannual variations in near-surface (upper 10 m) stratification and the timing of the spring bloom on the inner shelf. The data and associated analyses are suggested as being an important component to the development of the GEM program.	Fund under continuation of Project 02340. See Project 02340 for recommendation.	This project has been combined with 02340. See Project 02340 for recommendation.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02610	Kodiak Archipelago Youth Area Watch	T. Schneider/Kodiak Island Borough School District	ADFG	Cont'd 3rd yr.	$61.8	$61.8	$57.7	

Project Abstract

This project will engage students in projects with goals aligned with the general restoration efforts of the Trustee Council. Students and site coordinators will conduct interviews with local experts and document traditional ecological knowledge, publishing it in a Kodiak School District oral history magazine. Participation of Youth Area Watch adults and students in the annual Academy of Elders/Science Camp will be strongly encouraged. Such participation will serve as another avenue for more tribal members to learn about restoration efforts, scientific monitoring techniques, and occupations related to such work. The value and implications of traditional ecological knowledge will be strongly emphasized throughout the implementation of the project.

Chief Scientist's Recommendation

This is a popular and successful program to involve the youth of Kodiak Island in the restoration program. The project is in its third and final year, although funding is requested for FY 03. The success of students from this program in the regional Kodiak Science Fair is admirable and attests to the value of this program. Fund revised proposal, which reduces the Trustee Council contribution to the project.

Executive Director's Recommendation

Fund revised proposal, which reduces the amount of the Trustee Council contribution and clarifies in which EVOS projects the students will participate in FY 02. As with the Prince William Sound Youth Area Watch (Project \210), on which this project is modeled, Council funding is but a contribution to the program and strong financial support from the school district and/or other funding sources is required. This project is designed to involve local youth in restoration projects. FY 02 was expected to be the final year of Council support, but this might be the type of community effort that is appropriate under GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02628-BAA	Resurrection Bay Contaminant Survey	P. Homan/Qutekcak Native Tribe	NOAA	New 1st yr. 2 yr. project	$128.8	$0.0	$9.1	$0.0

Project Abstract

Qutekcak Native Tribe would like to lead the way in protecting Resurrection Bay from pollution and misuse. Immediate sources of pollution in the bay include industry, fisheries, wastewater treatment discharge, leaky septic systems, boat harbor, coal terminal, and large ships such as barges, ferries, and cruise ships. This project will collect twenty ocean floor sediment samples from Resurrection Bay and analyze them for contaminants including metals, coliform bacteria, pesticides, and other persistent organic pollutants. The results of the analyses will be publicized via public meetings, reports, and a website.

Chief Scientist's Recommendation

A properly designed sediment survey can provide valuable information about contaminant sources. This proposal is a good first attempt, but it has significant problems as written: (a) sampling methods are unspecified, (b) quality assurance procedures are not described, (c) collection and management costs are high, and (d) there is no identified expertise to interpret the data. Do not fund.

Executive Director's Recommendation

Do not fund. This project, which would collect and analyze sediment samples for evaluation of contaminants in Resurrection Bay, was initiated by local concern over a variety of pollutants that may be entering the bay. While GEM is likely to include some contaminants work, and will be designed to take into account local concerns, this proposal is premature at this stage of GEM development. In addition, the Chief Scientist has raised questions about the sampling locations and methods and the analytes proposed for analysis. The proposer should participate in the nearshore/intertidal monitoring workshop to be held in FY 02 (see Project 02395).

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02633	Acquisition of Chemical, Physical, and Biological Information on Kodiak Regional Water Quality	R. Ward/Kodiak Area Native Association	ADEC	New 1st yr.	$446.6	$0.0		$0.0

Project Abstract

This project will (a) develop nearshore monitoring stations to gather information on species composition and rates of settlement of shellfish, barnacles, algae, and other important marine organisms, (b) develop monitoring stations for remote telemetry of temperature, salinity, currents, zooplankton densities, and other data relevant to fisheries and oceanographic investigations, and (c) develop methods for utilization of satellite imagery technology through coordination with NASA (National Aeronautic and Space Administration).

Chief Scientist's Recommendation

This proposal identifies important opportunities for community-based sampling of biological and physical variables. Participation of Kodiak in community based sampling is desirable within GEM, but the proposal is premature with respect to GEM planning. Costs identified are high for a GEM program. Greater coordination, cooperation, and integration of proposed activities with those of other parts of the community on Kodiak, such as the Alaska Department of Fish and Game, the National Marine Fisheries Services, and the Fisheries Industrial Technical Center, need to be developed. Proposers are encouraged to participate in GEM planning workshops during FY 2002. Do not fund.

Executive Director's Recommendation

Do not fund. This proposal, which would initiate a community-based monitoring effort in the nearshore environment of the Kodiak region, is premature with respect to GEM planning. It is expected that community monitoring will be an aspect of GEM. The proposers are encouraged to participate in the nearshore/intertidal monitoring workshop to be held in FY 02 (see Project 02395).

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02634	Expanding the Seabird Tissue Archival and Monitoring Project (STAMP) Program for GEM	D.Roseneau/USFWS, G.York/BRD, P.Becker/NIST	DOI	New 1st yr. 1 yr. project	$54.9	$54.9	$0.0	$0.0

Project Abstract

This project will lay the ground work for expanding the Seabird Tissue Archival and Monitoring Project (STAMP) in the spill area. The project will include developing local community networks for collecting samples for the project, adding more seabird colony locations and species to the existing STAMP program, developing logistical plans for expanding STAMP in the Gulf of Alaska, and completing analytical work on existing samples to provide a database that will be used to design a long-term monitoring plan for GEM.

Chief Scientist's Recommendation

This proposal has objectives that appear to be premature with respect to GEM. The most appropriate way to proceed would be to characterize the spatial and temporal variability of contaminants in seabirds and to design the program based on the results of the analysis. It may be appropriate to fund the objective relating to further contaminant analysis of murre eggs at East Amatuli. Leveraging from other sources dedicated to persistent organic pollutant (POP) concerns should be found. Fund lower priority.

Executive Director's Recommendation

Defer decision on funding this project to December, pending availability of funds. If funded, funding would be contingent on submittal and approval of a revised Detailed Project Description and budget that address the Chief Scientist's concerns (base program design on an analysis of the spatial and temporal variability of contaminants in seabirds; delete objectives related to further contaminant analysis except for murre eggs at East Amatuli Island; secure additional funding sources). This project would expand the Seabird Tissue Archival and Monitoring Project (STAMP) in the spill area, which may be useful for GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02667	Effectiveness of Citizens' Environmental Monitoring Program	S. Mauger/Cook Inlet Keeper	ADEC	New 1st yr. 1 yr. project	$16.7	$16.7	$0.0	$0.0

Project Abstract

This project will analyze five years of past data from Cook Inlet Keeper's Citizens' Environmental Monitoring Program, the first consistent, credible, and coordinated community-based water quality monitoring program in Alaska. Keeper's stream ecologist will determine if sampling frequency, methods, parameters, and site selection are effective at meeting the monitoring objectives of detecting significant changes in water quality over time. The results will assist Cook Inlet Partners (Kenai Watershed Forum, Anchorage Waterways Council, Wasilla Soil and Water Conservation District) in refining their community monitoring efforts and may lead to future community-based monitoring programs.

Chief Scientist's Recommendation

This project will analyze the power of Cook Inlet Keeper's Citizens' Environmental Monitoring Program to detect change in water quality parameters. The Keeper program is an effective model for community-based sampling and this proposal is a good preparation for community based monitoring within GEM. Fund revised proposal, which clarifies the statistical approach.

Executive Director's Recommendation

Fund revised proposal, which clarifies the statistical approach for this study. This project will provide funding for Cook Inlet Keeper to analyze five years of data from their Citizens' Environmental Monitoring Program to determine if the monitoring protocols and sampling design are effective at detecting significant change in water quality over time. The project is good preparation for community based monitoring under GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02678-BAA	Identifying Community-Based Ways to Use Commercial Fisheries Bycatch for Scientific Gain	W. Wilson/LGL Alaska Research Associates	NOAA	New 1st yr. 1 yr. project	$128.1	$0.0	$0.0	$0.0

Project Abstract

This project will investigate the feasibility of using commercial fisheries bycatch to increase scientific knowledge of rare and infrequently-studied icthyofauna in the Gulf of Alaska. Initial efforts will include a comprehensive overview of commercial fisheries, vessel types, seasons, and locations most likely to yield regional bycatch samples useable for scientific purposes. Pilot research will be conducted with selected members of the fishing community to develop a statistically-valid experimental design at appropriate spatial scales. Sampling protocols will then be conducted to field-test the design. Additional methods and procedures will be described for the identification, preservation, and vouchering of specimens. Methods for data analysis and reporting of geospatial data will also be described. A final report will evaluate the sampling protocol and specify a future full-scale study design.

Chief Scientist's Recommendation

This project would explore the feasibility of using commercial fishing bycatch as a means of sampling Gulf of Alaska fishes to gather information about species composition, distribution, and age structure. A program such as this could be a useful component of GEM, although issues related to gear-type variation and accurate reporting of bycatch remain to be addressed if quantitative results are to be achieved. Also, GEM has not posed the questions that this project would address. The fact that this project would rely on the participation of community fishers is a strong plus. The scientific team is highly qualified to perform this work, which may be appropriate for future funding. Do not fund.

Executive Director's Recommendation

Do not fund. The Chief Scientist has raised concerns about how quantitative results would be obtained and the project's relationship to GEM. The project, which would conduct opportunistic sampling of fish species captured as bycatch in groundfish fisheries, has a strong community involvement component (i.e., reliance on commercial fishers).

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02680	Remote Delivery of Persistent Organic Contaminants in Alaska Fishes	S. Rice, J. Short, A. Moles/NOAA	NOAA	New 1st yr. 1 yr. project	$75.6	$75.6	$0.0	$0.0

Project Abstract

This project will determine the distribution of persistent organic contaminants in the flesh and ovaries of different year classes of chinook salmon from four major geographic areas of Alaska. A suite of contaminants, including pesticides, Polychlorinated biphenyls (PCBs), and chlorinated and unchlorinated hydrocarbons, with known implications for aquatic and human health, will be measured in two age classes of salmon. These will be salmon returning after only a year in saltwater and salmon returning after 3-5 years. This will give some measure of the extent of atmospheric distribution of industrial and agriculture pollutants over a range of rivers in Alaska.

Chief Scientist's Recommendation

This is a good effort by qualified investigators to characterize concentrations of POPs (persistent organic pollutants) in an important seafood product over a wide geographic area. Two of the sampling areas are outside of the spill area. There will be an interest by GEM in collecting data regarding the abundance and distribution of POPs in the Gulf of Alaska, but these measurements will likely be made in partnership with other funding agencies with a broader geographic mandate for contaminant assessment and the protection of public health. Defer pending determination of availability of matching funds.

Executive Director's Recommendation

Defer decision on funding this project to December, pending determination of availability of funds from other sources. If funded, funding will be contingent on submittal of overdue reports (00195, 00598). This project would sample the flesh and ovaries of salmon returning to the Kenai and Copper rivers, as well as two sites outside of the spill area--the Yukon and Unuk rivers. The flesh is important to consumers; the ovaries are important to the survival and success of progeny of the stock. It is anticipated that GEM will have a contributing role in the ongoing monitoring and study of contaminants.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02681	Placeholder: Nearshore/Intertidal Monitoring	To be determined		New 1st yr.		$50.0		

Project Abstract

Several proposals to conduct some form of nearshore/intertidal monitoring were submitted for FY 02. However, those proposals are premature pending development of a long-term monitoring scheme for the nearshore/intertidal area. A workshop to develop options for long-term monitoring will be held in FY 02 under Project 02395. This project simply reserves funds for possible nearshore/intertidal monitoring work later in FY 02, should the workshop recommend that such work be invited.

Chief Scientist's Recommendation

This project is simply a placeholder for potential nearshore/intertidal monitoring work in FY 02, depending on the results of the workshop to be held under Project 02395.

Executive Director's Recommendation

Defer decision on funding this project until the nearshore/intertidal workshop recommended for funding under Project 02395 has been held and recommendations for nearshore/intertidal monitoring under GEM have been developed. It is possible that the workshop will recommend a small amount of pilot or preliminary work to begin in FY 02. The $50,000 in this project has been set aside for that purpose.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
Habitat Protection & Improvements					$302.8	$302.8	$0.0	$0.0
02126	Habitat Protection and Acquisition Support		ALL	Cont'd	$161.8	$161.8		

Project Abstract	Chief Scientist's Recommendation	Executive Director's Recommendation
This project will cover certain expenses incurred by Trustee agencies in receiving title to parcels acquired by the Trustee Council.	Proposal not reviewed.	Fund. This project will fund the Alaska Department of Natural Resources and the U.S. Fish and Wildlife Service to complete in FY 02 acquisitions that are in progress in FY 01. In FY 02, additional habitat protection activity will occur under a grant to The Nature Conservancy and The Conservation Fund approved by the Trustee Council in January 2001. The Council's resolution on the grant identified specific support activities that will continue to be conducted by the land managing agencies (e.g., appraisal review, title review, hazardous materials inspection, and NEPA compliance), and the costs of those activities will also be funded through this project. However, because the grant is not yet in place, parcels to be purchased under the grant, and agency costs associated with those parcels, have not been identified. The Council will likely be asked to approve these additional costs in December. [Note: This project will be funded outside of the regular FY 02 work plan of research, monitoring, and general restoration projects.]

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02621	Kenai River Flats Conservation Easement and Public Education	M. Kuwada/ADFG	ADFG	New 1st yr. 1 yr. project	$141.0	$141.0	$0.0	$0.0

Project Abstract

This project will help protect approximately 600 acres of wetlands on the Kenai River Flats near the city of Kenai. The acquisition of a conservation easement for the property and construction of a boardwalk will protect sensitive coastal wetlands, high value waterfowl habitat, and two anadromous fish streams, and will provide new educational and recreational opportunities for the public. The conservation easement will be purchased by The Conservation Fund using already-approved funds from a North American Wetlands Conservation Act grant. The easement will specify that the property be preserved in a natural state and protected against incompatible development. A boardwalk and viewing platform will be constructed using EVOS funds to provide recreational birdwatching and educational opportunities. The boardwalk and viewing platform are essential for obtaining the City of Kenai's support for the conservation easement.

Chief Scientist's Recommendation

The Trustee Council has made a tremendous investment in the Kenai River through habitat protection and restoration as well as through fisheries research and management. Yet there are still significant needs and opportunities to help maintain and restore fisheries resources and recreation services on this world class salmon stream. This project would probably contribute to long-term protection of Kenai River resources, but the proposal itself presents a less-than-compelling case for how the proposed boardwalk and viewing platform would do that. Moreover, as presented, the linkages to resources and services injured by the oil spill is weak or absent. Do not fund as proposed.

Executive Director's Recommendation

Defer decision on funding this project to December, pending receipt of further information. This project may be of important restoration benefit, but the proposal does not clearly describe how the proposed boardwalk and viewing platform would contribute to the Trustee Council's restoration objectives. In addition, indications of community and agency support, including from the Alaska Department of Natural Resources and the U.S. Fish and Wildlife Service, are not provided. If funded, funding would be contingent on satisfactory NEPA (National Environmental Policy Act) review. This project would complement an effort currently underway with other funds (National Wetlands Conservation Act) to acquire a conservation easement on 600 acres on the Kenai River Flats. Protection of the Kenai River has been a high priority of the Council. The sort of improvement proposed in this project is similar to the improvements constructed under Project /180 (Kenai Habitat Restoration and Recreation Enhancement).

Data Management & Information Transfer					$994.2	$217.7	$73.7	$0.0
02290	Hydrocarbon Database and Interpretation Service	J. Short, B. Nelson/NOAA	NOAA	Cont'd 11th yr.	$35.0	$35.0	$35.0	

Project Abstract

This ongoing project provides data and sample archiving services for all samples collected for hydrocarbon analysis in support of Trustee Council projects. These data represent samples collected since the oil spill in 1989 to the present and include environmental and laboratory National Resource Damage Assessment and restoration data. Additionally, this project provides interpretive services for hydrocarbon analysis, public releases of the hydrocarbon and pristane databases, and storage and maintenance of the hydrocarbon sample archives.

Chief Scientist's Recommendation

The restoration program needs this project for FY 02, as it maintains the integrity of the hydrocarbon database, makes new additions, and supplies interpretative services. It is recommended that the Trustee Council fund this program through FY 02, to the end of the settlement period. However, the need for this program has not been assessed with regard to GEM and other priorities that will begin in FY 03. Therefore, there should be no guarantee or recommendations for funding beyond FY 02. Fund.

Executive Director's Recommendation

Fund FY 02 only contingent on submittal of overdue report (00195) and manuscript (00598). This project is the ongoing analysis and interpretation of hydrocarbon data for other Trustee Council funded studies. However, the need for the database has not been assessed with regard to GEM, and needs to be. Funding for FY 03 may be considered following such an assessment.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02455	GEM Data System	Restoration Office	ALL	Cont'd 2nd yr.	$105.0	$105.0		

Project Abstract	Chief Scientist's Recommendation	Executive Director's Recommendation
This project will continue work on the data system for GEM by hiring a data system manager to provide the leadership necessary for developing this essential part of the GEM program.	Proposal not yet available for review. Data management will be a critical component of GEM.	Fund contingent on preparation and review of a Detailed Project Description and budget. This project will provide funding for a GEM data manager. The cost shown above is an estimate.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02475-BAA	GEM Data System Specification	S. Marley/ECOlogic Corp.	NOAA	New 1st yr. 1 yr. project	$250.9	$0.0	$0.0	$0.0

Project Abstract	Chief Scientist's Recommendation	Executive Director's Recommendation
This project will produce the Operations Concept and Systems Requirements Specification for the data system for GEM. This project will capitalize on the work already performed under Project 00455, and through a detailed requirements definition approach, will develop the detailed description necessary to release a formal Request for Proposals (RFP) for the permanent system.	The proposal emphasizes the archival function of the GEM data system and the importance of understanding the needs of users. The cost of the principal investigator is extremely high, and the proposal appears to make inadequate use of support personnel. In addition, the proposal appears to be premature until the scope of GEM is more fully defined. Do not fund.	Do not fund. This project is premature until a GEM data manager is hired (see Project 02455) and the scope of GEM is more fully defined. At that time, a proposal such as this may be solicited.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02536	Synthesis of Spill Damaged Resource Information into the Heritage Data Management System	T. Gotthardt, K. Boggs/UAA	ADFG	New 1st yr. 1 yr. project	$118.2	$0.0	$0.0	$0.0

Project Abstract	Chief Scientist's Recommendation	Executive Director's Recommendation
This project will synthesize conservation information pertaining to species and ecosystems damaged by the oil spill into the Heritage Data Management System (HDMS). HDMS is part of an effort by The Nature Conservancy and 86 Natural Heritage Programs throughout the Western Hemisphere to document information on terrestrial and nearshore endangered species and ecosystems. It is the largest biodiversity conservation effort of its kind. The incorporation of spill affected resources information into HDMS would ensure linkage of EVOS information to broader based conservation efforts. The project will also evaluate the effectiveness of using HDMS as an integral tool within GEM to track the recovery status of injured resources.	Among other objectives, this project would make widely available some of the scientific data from the Trustee Council's restoration efforts. This would be a great public service. However, the project is premature until a GEM data manager is hired and options for information management and transfer under GEM have been developed. Do not fund.	Do not fund. This project is premature until a GEM data manager is hired (see Project 02455). One of the initial tasks of the data manager will be development of options for information management and transfer under GEM. This should include consideration of using the Heritage Data Management System as part of the overall GEM information management strategy.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02608	Permanent Archiving of Specimens Collected in Nearshore Habitats	N. Foster/UAF	ADFG	New 1st yr. 1 yr. project	$61.6	$61.6	$0.0	$0.0

Project Abstract

This project will support acquisition and archiving of marine invertebrate specimens collected as part of EVOS assessment studies in Prince William Sound between 1990 and 1995. Specimens represent a time series of samples from eelgrass and kelp forest habitats. As a result of these efforts, there will be an improved set of baseline data for the marine biota of Prince William Sound.

Chief Scientist's Recommendation

Archiving these specimens will make them accessible to the scientific community and others, which might be useful for GEM. The nearshore/subtidal specimens are of a higher priority. Fund revised proposal, which limits activity to nearshore/subtidal specimens only.

Executive Director's Recommendation

Fund revised proposal, which limits the project's scope to the archiving of nearshore/subtidal specimens only and clarifies the University's commitment to long-term maintenance of the specimens. This project addresses a worthwhile endeavor, which is archiving specimens from Project CH1A (Coastal Habitat Damage Assessment) at the University of Alaska Museum. The archives could serve an important reference function for GEM as well as provide a useful public service.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02637	Online Early Life History Database for the Northeast Pacific Ocean, Gulf of Alaska and Southeast Bering Sea	J. Duffy-Anderson/NOAA	NOAA	New 1st yr. 2 yr. project	$143.7	$0.0	$1.2	$0.0

Project Abstract

This project will develop a public, online, early life history database for more than 20 years of ichthyoplankton data from the northeast Pacific Ocean, Gulf of Alaska, and southeast Bering Sea. The database will merge sample collection information with a larval identification guide and ichthyoplankton distributional atlas into a searchable, internet-based database. This database will provide global access to these resources, providing a platform for the generation of hypotheses and offering managers and other users access to accurate, relevant information on ichthyoplankton distributions in Alaska.

Chief Scientist's Recommendation

This proposal is a very worthwhile endeavor but it is not immediately related to EVOS recovery objectives and is wider than the geographic scope of GEM. The work could aid GEM modeling efforts in the future in the northern Gulf of Alaska. Partnerships for funding with the North Pacific Research Board and others should be pursued. Do not fund.

Executive Director's Recommendation

Do not fund. The geographic scope of this project, which would create a database merging ichthyoplankton cruise data with a larval identification guide as well as archive some ichthyoplankton samples, is broader than GEM. However, such a database might be useful to GEM modeling efforts in the future. If this proposal is resubmitted in the future, funding contributions from other interested entities should be sought.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02643	Design of the Environmental Specimen Bank Program for GEM	P. Becker/NIST	DOI	New 1st yr. 1 yr. project	$85.4	$0.0	$0.0	$0.0

Project Abstract

This project will develop a design and implementation plan for an Environmental Specimen Bank component to GEM specifically designed for environmental contaminants monitoring and research. This plan will provide organizational framework, facility requirements, identification of specimens of interest, collection and banking protocols, recommendations on specimen sizes and frequency of collections, establishment of database network with other kinds of archival facilities associated with GEM, recommendations on specimen access policy, identification and development of collection platforms (including partnership with local Alaska Native communities), and cost estimates for instituting and maintaining an Environmental Specimen Bank system for GEM.

Chief Scientist's Recommendation

The project offers a means to systematically develop a community-based contaminants monitoring network that may be of interest to GEM. The project team is highly qualified. At this stage of GEM planning it is not possible to determine if the scope of the proposal is appropriate. Do not fund.

Executive Director's Recommendation

Do not fund. This project would design a specimen bank for GEM, and make recommendations on specimen types, collection and banking protocols, facility requirements, tracking databases, access policy, and annual costs. This may be a worthwhile task, but at this stage of GEM planning the proposal is premature. Any efforts in this regard in the future should be coordinated with the joint state/federal/Alaska Native Wild and Traditional Foods Safety Committee.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02646-BAA	Information Dissemination through the Web: Developing an Interactive Database on Southcentral Alaskan Seaweeds	G. Hansen/OSU, M. Stekoll/UAS	NOAA	New 1st yr. 3 yr. project	$58.0	$0.0	$37.5	$0.0

Project Abstract

The macrobenthic marine algae or seaweeds are an integral component of Alaska's nearshore ecosystem. They are the base of the food chain for many marine animals and have long been used as part of the diet of indigenous peoples. Surprisingly, the correct identification of most algal species is still elusive to many people. In order to begin to overcome this problem, this project will produce a Web-based database of algal images and distributions that will facilitate species identifications. With this as a reference, the project will query Alaska Native communities for information on the traditional uses of the species and add this data to the final product. The website will develop incrementally as species are added and comments from users are incorporated. [Note: This project also requested $26,900 for FY 04.]

Chief Scientist's Recommendation

This proposal from a qualified principal investigator to develop a web-based atlas of seaweeds of Alaska does not make a compelling case for contributing to restoration objectives. The past commitment to supporting publications of checklists and species descriptions for marine algae should suffice to form a record against which subsequent ecological change can be assessed. This type of product may be relevant to GEM in the future, but making commitments to a web-based atlas at this time seems premature. Do not fund.

Executive Director's Recommendation

Do not fund based on Chief Scientist's recommendation. The Trustee Council supported these proposers in FY 01 (Project 01551) to prepare a manuscript on the occurrence and distribution of marine microalgae in the spill area, based on 7,300 specimens from Project CH1A/Coastal Habitat Damage Assessment. The manuscript, which will consist of checklists and species descriptions, should form an adequate record for assessing ecological change, and that a web-based atlas is not a priority at this time.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02655-BAA	Transition Support for the GEM Data Manager	C. Falkenberg/ECOlogic Corp.	NOAA	New 1st yr. 1 yr. project	$120.3	$0.0	$0.0	$0.0

Project Abstract

This project will support the GEM data manager during FY 02 in order to ease the transition to the GEM data system. Tasks will address the challenge of formulating a GEM data system, the rescue of legacy EVOS data, and the integration of the administrative databases. Although these are the priorities that have emerged from Project 00455/Evaluation of a Data System for GEM, we anticipate that the data manager will set the final priorities and select one or more of the tasks proposed.

Chief Scientist's Recommendation

This project would provide support to the GEM data manager in the design of the GEM data system. This type of support is likely necessary. However, the degree and extent to which such support is needed depends on the experience and credentials of the person eventually hired to be the data manager. Placing funds in the GEM planning project (Project 02630) to provide support after the data manager is hired is the preferred approach. Do not fund.

Executive Director's Recommendation

Do not fund. This project is premature until a GEM data manager is hired (see Project 02455). At that time, once the experience and credentials of the data manager are known, the degree to which such support may be needed will also be known. The likely approach at that time will be to include contractual funds in Project 02630/GEM Planning. The cost of this proposal as written is quite high, particularly the personnel costs.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02668	Developing an Interactive Water Quality and Habitat Database and Making it Accessible on the Web	J. Cooper/Cook Inlet Keeper	ADEC	New 1st yr. 1 yr. project	$16.1	$16.1	$0.0	$0.0

Project Abstract

The project partners have come together to form a database committee to create a consistent data management system where all citizens groups and agencies can equally share, report, and review their water quality and habitat data. The committee's objective is to make data more accessible and more useful to decision makers, stakeholders, resource managers, and the public. The committee will uplink a shared interactive database on the Internet where it can be viewed and queried with GIS watershed maps, photos, and graphs so that it is user-friendly, educational and meaningful. Access to this data will help facilitate a better understanding about threats to, and solutions for, water quality and habitat.

Chief Scientist's Recommendation

The Trustee Council has spent $1 million over the last three years to create the Cook Inlet Information Management and Monitoring System (CIIMMS), in part to address the needs identified in this project. The proposal does not make a convincing case for why CIIMMS, or the other systems listed, cannot serve as the necessary vehicle for meeting the data exchange goals identified. Defer pending clarification of this issue.

Executive Director's Recommendation

Defer decision on funding this project to December, pending resolution of the Chief Scientist's concerns about the relationship between this proposed water quality database and CIIMMS (Cook Inlet Information Management and Monitoring System, Project /391), in which the Trustee Council has made a major financial investment. This project would provide funding for Cook Inlet Keeper to participate in creating a single unified database for water quality and habitat data collected by Keeper and other citizen-based monitoring groups in Cook Inlet. It has good cost sharing with other interested entities.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
Community Involvement/Public Outreach/Other					$1,424.8	$1108.0	$0.0	$0.0
02052	Community Involvement/Planning for GEM	P. Brown- Schwalenberg/CRRC	ADFG	Cont'd 8th yr.	$214.2	$180.0	$0.0	

Project Abstract

In FY 02, this project will continue to actively involve residents of Tatitlek, Chenega Bay, Port Graham, Nanwalek, Cordova/Eyak, Seward/Qutekcak, Seldovia, Valdez, Kodiak Island Region/Ouzinkie, and the Alaska Peninsula Region/Chignik Lake in the restoration program through a network of local facilitators. In addition, the project will work to address the future of community involvement with regard to the Gulf Ecosystem Monitoring (GEM) program. In FY 02, the project will focus on three objectives: (a) designing a community based research and monitoring program, (b) identifying specific research and monitoring activities that fit within the GEM program, and (c) developing possible pilot projects for FY 03.

Chief Scientist's Recommendation

The community involvement project is a very valuable part of the restoration program. In principle, this proposal makes sense--i.e., to develop community monitoring plans and Tribal Natural Resource Management Plans that have tangible linkages to GEM. If successful, these links will contribute greatly to the community involvement and public participation objectives of GEM. However, this project's track record in producing products could improve, and it is essential that the project leaders foster realistic expectations as they attempt to define meaningful community involvement. There are objectives for FY 02 that were also in the FY 01 proposal and two overdue reports. There are also FY 00 objectives that have not been met. Fund contingent on these issues being satisfactorily resolved.

Executive Director's Recommendation

Fund interim amount ($45,000), to continue current project in the short term, contingent on (a) submittal and review of additional information regarding FY 00 and FY 01 project tasks and the schedule and strategy for completion of the Tribal Natural Resource Management Plans and (b) submittal of overdue reports (00052, 01131). Defer balance ($135,000) to December, pending further discussions with the principal investigator about the longer term objectives of the project. The total amount of funding for FY 02 (interim amount plus balance) is not expected to exceed $180,000, which is the amount originally projected for FY 02. This project was originally designed to facilitate communication among the Trustee Council, scientists, and residents of the spill area in regard to the restoration effort. As the Council's efforts have shifted from restoration to long-term monitoring, the project's emphasis has shifted to providing technical assistance to five pilot communities (Tatitlek, Port Graham, Nanwalek, Ouzinkie, Cordova/Eyak) to participate in the development of GEM and to further develop their natural resource programs and stewardship capacity. FY 02 was expected to be the final year of Council support. However, some kind of community effort will likely be a future part of GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02250	Project Management	All Trustee Council Agencies	ALL	Cont'd	$271.4	$181.7		

Project Abstract

Project management represents those costs incurred by the state and federal Trustee agencies in fulfilling their responsibility to ensure that individual projects are managed consistent with the Memorandum of Agreement and Consent Decree, the Restoration Plan, and Trustee Council authorization. Tasks performed by project managers include coordinating activities between principal investigators and the Restoration Office, reviewing project expenditure activity, assisting in the development of project proposals, and tracking project reports.

Chief Scientist's Recommendation

Proposal not reviewed.

Executive Director's Recommendation

Fund. The FY 02 funding level is a reduction from the amount approved for FY 01 ($284,300), consistent with the reduction in the annual funding cap for the overall work plan. A decision on whether or not to provide any project management funds once funding has shifted to the Restoration Reserve (FY 03 and beyond) has not yet been made. Project management helps provide accountability for the work plan process.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02350	Alaska SeaLife Center Bench Fees		ALL	Cont'd	$310.4	$310.4		

Project Abstract

This project will pay for the use of labs and office space, as well as other direct expenses, at the Alaska SeaLife Center for those projects funded by the Trustee Council that have a SeaLife Center component. Three FY 02 proposals include a SeaLife Center component: Project 02423/Population Change in Selected Nearshore Vertebrate Predators, 02558/New Technologies for Monitoring Harbor Seal Health, and 02674/Assessing Pigeon Guillemot Restoration Techniques.

Chief Scientist's Recommendation

This is an essential cost of doing business at the Alaska SeaLife Center, and should be funded.

Executive Director's Recommendation

Fund. FY 02 bench fees consist of $120,300 for Project 02423/Population Change in Selected Nearshore Vertebrate Predators, $153,200 for Project 02558/New Technologies for Monitoring Harbor Seal Health, $16,600 for Project 02674/Assessing Pigeon Guillemot Restoration Techniques, and $20,300 in general administration for the Alaska Department of Fish and Game, which administers the bench fee contract on behalf of the Trustee Council. Prior to publication of the final work plan, this project will be dismantled and the fees added to the individual research projects which they support. The Alaska SeaLife Center charges bench fees for use of its facilities by EVOS researchers.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02360-BAA	The *Exxon Valdez* Oil Spill: Guidance for Future Research Activities	C. Elfring/Polar Research Board, NRC	NOAA	Cont'd 3rd yr. 3 yr. project	$90.1	$90.1	$0.0	$0.0

Project Abstract

The National Research Council's Polar Research Board and Board on Environmental Studies and Toxicology have appointed a special committee to review the scope, content, and structure of the Trustee Council's two GEM documents, the draft Science Program and the draft Monitoring and Research Plan. To date, the committee has provided guidance in two documents: a November 2000 letter commenting on the schedule and process by which the draft Monitoring and Research Plan would be developed and a February 2001 Interim Report providing detailed comments on the draft science program, including missions, goals, administration, scale, data management, and community involvement elements. The committee's next and final task will be to prepare a final report analyzing whether the Monitoring and Research Plan is complete, scientifically sound, and meets the expectations of the Trustee Council. This task will be conducted when the draft plan is available for review. As currently scheduled, the committee will receive the draft plan in August and hold a meeting to begin our review September 18-19, 2001. The committee will spend the fall preparing its final report. The report is expected to go to outside review in January 2002 and be delivered to the Trustee Council in April 2002.

Chief Scientist's Recommendation

Fund. National Research Council participation is essential to the successful implementation of GEM.

Executive Director's Recommendation

Fund. This project, which is providing important external review of GEM, began in FY 00. The National Research Council (NRC) has provided interim comments on the GEM Science Program. FY 02 activities will include review of the draft GEM Monitoring and Research Plan and preparation of a final report containing conclusions and recommendations on GEM.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02535	EVOS Trustee Council Restoration Program Final Report	J. Hunt/EVOS Restoration Office	ALL	Cont'd 2nd yr. 2 yr. project	$52.4	$52.4	$0.0	$0.0

Project Abstract

This project will provide a final report for the activities of the Trustee Council, starting with the earliest damage assessment efforts and ending with the FY 02 Work Plan and disbursements of the final payment from Exxon. It will also include a complete history of the litigation leading to the civil settlement, which funds the Council. This project will increase public awareness and understanding of EVOS restoration activities, policies, and procedures. It will provide agencies and groups (facing a similar trustee situation) with a detailed history of the *Exxon Valdez* Oil Spill Restoration process, including highlights and pitfalls, so that others can benefit from lessons learned in the groundbreaking EVOS effort. This published history will include references and an index.

Chief Scientist's Recommendation

This is the second year of a project to report on the decade-long restoration program following settlement of the governments' claims against Exxon. This project will help bring closure to the EVOS experience in the minds of the public, and in that sense it helps restore lost passive uses. Further, the EVOS program and process are unique in terms of the nation's environmental history and should be documented both for history's sake and also in the event that similar situations arise in the future. The principal investigator is excellent. Fund.

Executive Director's Recommendation

Fund. This project is designed to increase public awareness and understanding of EVOS restoration activities, policies, and procedures through publication of a report that comprehensively describes the Trustee Council's activities from the time of the spill through FY 02, when the final payment from Exxon will be received. The author of the report is Joe Hunt, the Council's former Communications Coordinator. The target date for publication is September 2002.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02550	Alaska Resources Library and Information Services (ARLIS)	All Trustee Council Agencies	ALL	Cont'd	$144.3	$93.4		

Project Abstract

This project is the Trustee Council's contribution to the Alaska Resources Library and Information Services (ARLIS). ARLIS serves as a central access point for information generated through the restoration process. In addition, ARLIS acts as the public repository for reports and other materials generated as a result of the cleanup, damage assessment, and restoration efforts following the spill.

Chief Scientist's Recommendation

The Alaska Resources Library and Information Services (ARLIS) performs an important service by providing world-wide access to what are now voluminous materials generated from the whole EVOS experience--spill response, damage assessment, restoration, etc. The availability of these materials advances the full range of recovery objectives, and requests for EVOS materials at ARLIS are significant, about 15% of all library uses. This project should be funded through FY 02. The more difficult question is how ARLIS relates to GEM and, over the longer term, what funding, if any, is appropriate. Fund.

Executive Director's Recommendation

Fund continuation of one librarian at the Alaska Resources Library and Information Services (ARLIS). Trustee Council contributions in FY 03 and beyond may be reduced further as the transition to GEM is completed. ARLIS provides an important service for documents and other materials produced through the damage assessment and restoration processes. The Council's original funding commitment to ARLIS was through FY 01 only and how ARLIS might relate to the GEM program is not clear at this time.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02570	Book on EVOS Science for General Readers	S. Loshbaugh/Freelance Writing	ADFG	New 1st yr. 1 yr. project	$47.0	$0.0	$0.0	$0.0

Project Abstract

This project will produce a publication-ready, book-length manuscript about the scientific and restoration projects following the oil spill. Written for the intelligent lay reader, it will emphasize the cutting-edge quality, adventurous experiences, ethical issues and lucid, non-technical explanations of findings. Based on interviews, symposium presentations and review of the technical literature, it will include discussion of scientists' personal motivations, partnerships between Western and indigenous knowledge systems, legal entanglements, technical advances, the interdisciplinary ecosystem approach, and the implications both process and findings hold for future research design, science in the public arena, and the environment.

Chief Scientist's Recommendation

The proposer, who has a science background and considerable experience in journalism, has invested considerable effort in outlining a book on the EVOS experience and restoration science program. Such a book could help bring closure to the oil spill experience and restoration program, which would be helpful and timely. However, the scope of the book is overly broad--for example, mixing spill response and restoration science--and the timetable is unrealistically short. Also, the budget does not anticipate any costs for subsidizing publication, which seems likely unless the author can interest a major publisher in this account. This project overlaps substantially with Project /535 (EVOS Final Report) already funded by the Trustee Council, and much of the need for the research proposed here could be short-circuited by waiting for more technical syntheses on the restoration program to be completed. Do not fund.

Executive Director's Recommendation

Do not fund. Although this proposal is much improved over the version submitted last year (a detailed outline and a draft of the opening pages of the book have been included), the proposed contents overlap substantially with the Trustee Council final report being prepared under Project /535. The part that does not overlap is the scientific synthesis, which might be better handled by more experienced scientific writers. Such a proposal (Project /600) is also under consideration by the Council.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02629-BAA	Development of a Paradigm for Ecosystem Monitoring	R. Thorne/PWSSC	NOAA	New 1st yr. 1 yr. project	$95.0	$0.0	$0.0	$0.0

Project Abstract

This project will evaluate the GEM draft plan and will draft recommendations to GEM that would improve research efficiency and focus. The National Research Council recommended a list of modifications to GEM. However, we believe that they missed some potentially serious issues regarding the limitations to existing science methods identified by GLOBEC (Global Ocean Ecosystem Dynamics) planners in the early 1990's, such as the limitations of measurement, correlation-based analyses, uncoupled prediction-obervation, the individual-organism approach, and more. Our experience with programs of the Prince William Sound Science Center, Oil Spill Recovery Institute, and Sound Ecosystem Assessment addressed these issues with some success.

Chief Scientist's Recommendation

Further dialogue and cooperation between Oil Spill Recovery Institute (OSRI) and GEM personnel is to be encouraged, but under a mechanism different than that proposed here. Opportunities for participation in development of GEM during FY 02 may be provided through workshops in which participants could be funded, if necessary, to participate . Do not fund.

Executive Director's Recommendation

Do not fund. This project would provide funding for Prince William Sound Science Center (PWSSC) personnel to formally evaluate the GEM plan, with joint funding from the Trustee Council and the Oil Spill Recovery Institute (OSRI). PWSSC's experiences and insights are welcome contributions to the Council's GEM process, and several opportunities for contributing such input have been provided over the last two years. Further dialogue and cooperation is expected to continue in FY 02. Formal evaluation of GEM is underway by the National Research Council (Project 02360).

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
02630	Planning for Long-Term Monitoring and Research Program	Restoration Office	ALL	Cont'd	$200.0	$200.0		

Project Abstract

In March 1999, the Trustee Council earmarked an estimated $120 million of Restoration Reserve funds for a long-term monitoring and research program in the spill area and adjacent northern Gulf of Alaska. Development of what is now called the Gulf Ecosystem Monitoring and Research (GEM) program was initiated in FY 99 and will continue through FY 02. In FY 00, a draft GEM Science Program (April 2000) was developed and submitted to the National Research Council for review. In FY 01, follow-up on the National Research Council's recommendations on the GEM Science Program is occurring. Development of a draft Monitoring and Research Plan is underway in FY 01 and will be completed in FY 02. This project is accomplished through the combined efforts of the Restoration Office and Chief Scientist.

Chief Scientist's Recommendation

Proposal not reviewed, but Detailed Project Description and budget were coordinated with Chief Scientist.

Executive Director's Recommendation

Fund interim amount ($63,800). Defer decision on balance of funds (roughly $136,200) to December, pending further clarification of the work that will be needed in FY 02. This project will continue the planning necessary to carry out the Trustee Council's decision to dedicate approximately $131 million of Restoration Reserve funds in support of long-term monitoring and research in the spill area and adjacent northern Gulf of Alaska. The interim funds will be used for (a) a Fall intern to assist with development of GEM, (b) a modeling workshop, tentatively scheduled for October 2002, (c) participation in the PICES meeting in October 2002 and other meetings with other potential collaborators, and (d) development of the first GEM invitation, scheduled to be released in Spring 2002.

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	FY02 Request	FY02 Recom.	FY03 Request	FY03 Recom.
Public Information/Science Management/Administration					$1,500.0	$1500.0		
02100	Public Information, Science Management, and Administration	All Trustee Council Agencies	ALL	Cont'd	$1,500.0	$1,500.0		

Project Abstract	Chief Scientist's Recommendation	Executive Director's Recommendation
This project provides overall support for science management, public involvement, and administration of the restoration program. This includes funding for the Trustee Council staff working at the direction of the Executive Director, the scientific peer review process, public involvement efforts including the active participation of the 17-member Public Advisory Group (PAG), and Trustee agency participation in the restoration program.	Proposal not reviewed.	Fund. This project provides overall support for administration and implementation of the restoration program. [Note: This project will be funded outside of the regular FY 02 work plan of research, monitoring, and general restoration projects.]

GEM

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401. Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

MEMORANDUM

TO: Trustee Council

FROM: Molly McCammon
Executive Director

DATE: July 30, 2001

RE: GEM follow-up

Enclosed is the latest draft of the GEM Program Document. We have had two recent review sessions – one with the Public Advisory Group and one with the Trustee agency liaisons. These were very helpful and resulted in us re-organizing the whole document in order to improve readability. Overall, both groups were very positive about the direction of the document, and most comments were easily accomodated. Because of the recent organizational changes however, we have only been able to review each individual chapter, and not the revised document as a whole, until now. Consequently, there are still minor revisions that need to be made, in addition to final proofing and editorial word-smithing. Attached you will find a working list of the changes we will be incorporating into the next version.

At the August 6 meeting, I will be asking for your approval to move forward with this draft as the "NRC review draft". Our plan is to make the final edits and revisions by August 15, send the draft to the printer, and submit the draft to the NRC by September 1, 2001. Phil Mundy and I will be meeting with the NRC review committee in Seattle September 18-19 to discuss the latest draft. The committee meets again in November in a closed-door meeting to begin drafting their final report, which we should receive in March 2002.

REVISIONS TO GEM PROGRAM DOCUMENT

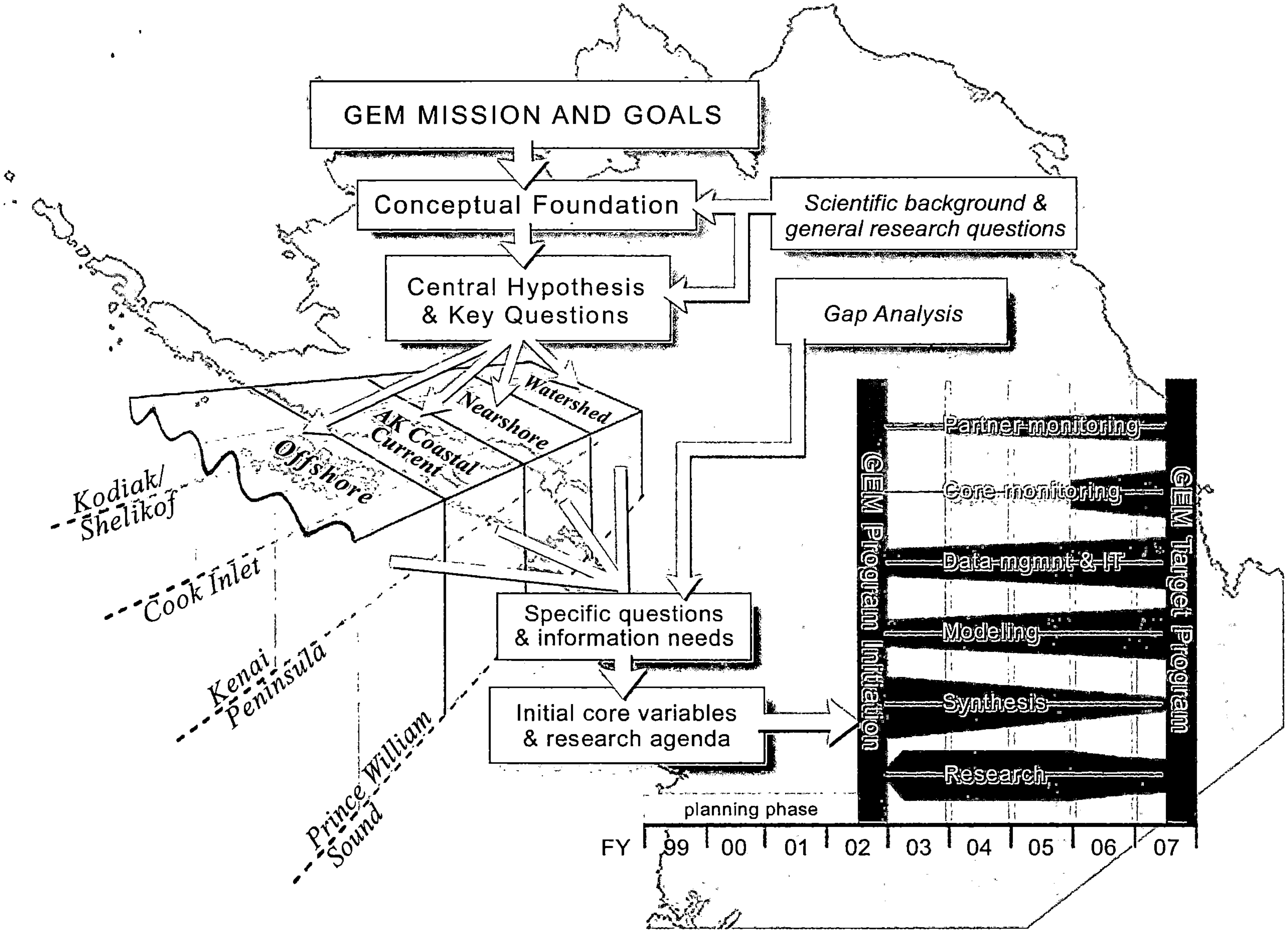
July 30, 2001

Content

1. Need to add section on community involvement, stewardship and TEK. Somehow these did not get incorporated into the latest draft.
2. Volume I, Chapter 2 – Human Activities and their Impacts – still needs revision. In addition, we will be contracting with someone (economist, social scientist?) to expand this to the level of the chapters in the Scientific Background (Volume II, Chapter 3) and incorporate all, or parts, into that chapter.
3. Two policy decisions –Can we use principal investigators to provide some level of peer review for other projects? Should we revisit the issue of not funding "normal agency management?"
4. Executive summaries need to be added for overall document and for Scientific Background, Volume II, Chapter 3.
5. Add discussion of salmon life cycle (with figure from Sustainable Salmon Report) somewhere in Volume I as example of GEM approach with management application.

Style

1. A number of figures are still being worked on.
2. Final edits and proofing needs to be done.
3. Possibly add acronyms & Web links appendix to Volume I also?



GEM MISSION AND GOALS
Conceptual Foundation
Scientific background & general research questions
Central Hypothesis & Key Questions
Gap Analysis
Watershed
Nearshore
AK Coastal Current
Offshore
Kodiak/ Shelikof
Cook Inlet
Kenai Peninsula
Prince William Sound
Specific questions & information needs
Initial core variables & research agenda
GEM Program Initiation
GEM Target Program
Partner monitoring
Core monitoring
Data mgmnt & IT
Modeling
Synthesis
Research
planning phase
FY 99 00 01 02 03 04 05 06 07

Gulf of Alaska **E**cosystem **M**onitoring and Research Program (GEM)

Volume I
Strategic Plan for Monitoring and Research

Volumes I and II together should be referred to as the GEM Program Document.

Review Draft – July 30, 2001

Exxon Valdez Oil Spill Trustee Council
645 G Street, Suite 401
Anchorage, Alaska 99501
www.oilspill.state.ak.us
restoration@oilspill.state.ak.us
907-278-8012
800-478-7745, within Alaska
800-283-7745, outside Alaska

ACKNOWLEDGMENTS

The primary authors of the GEM Program Document are Molly McCammon, Phil Mundy, and Bob Spies. Editors for the document were Molly McCammon, Phil Mundy, Bob Spies, and Judy Griffin.

Credit goes to the following authors in Volume II: Chapter 3 – Ted Cooney, Jim Bodkin, Anne Hollowed, Lloyd Lowry, Phil Mundy, Peter Olsson, Charles Peterson, Bob Spies, Alan Springer, Tom Weingartner; Chapter 4 – Phil Mundy and Bob Spies; Chapter 5 – Gretchen Oosterhout; Chapter 6 – Charles Falkenberg; Appendix A – Michael H. Martin; Appendix B – Kerim Ayden; Appendix C – Joe Sullivan, Dede Bohn, Veronica Christman, and Sandra Schubert, Appendix D and E, Phil Mundy. Cherri Womac has been instrumental in preparing the entire document.

Many people made material or intellectual contributions to the GEM Program Document. Because the number of contributors and advisors is so large, we apologize if we inadvertently left your name off this list.

The efforts of the following are gratefully acknowledged: Alisa Abookire, Ken Adams, Vera Alexander, Fred Allendorf, Paul Anderson, Peter Armato, Shannon Atkinson, Jim Ayres, Torie Baker, Kris Balliet, Hal Batchelder, Bill Bechtol, Catherine Berg, Brock Bernstein, Chris Blackburn, Jim Blackburn, John Blaha, Jim Bodkin, Dede Bohn, James Brady, Stephen Braund, Evelyn Brown, Patty Brown-Schwalenberg, Al Burch, Vern Byrd, Robert Clark, Dave Cobb, Ken Coyle, Ted Cooney, Seth Danielson, Tom Dean, Robert DeVelice, Jane DiCosimo, Gary Drew, Janet Duffy-Anderson, Doug Eggers, Dave Eslinger, Gary Fandrei, Bob Foy, Steve Frenzel, Carol Fries, Fritz Funk, Dan Gillikin, David Goldstein, Andy Gunther, Gary Gury, Ed Harrison, Bill Hauser, Robert Henrichs, Ken Holbrook, Anne Hollowed, Brett Huber, Gary Hufford, Charlie Hughey, Dan Hull, Joe Hunt, Henry Huntington, David Irons, Lisa Ka'aihue, Tom Kline, Gary Kompkoff, Jan Konigsberg, Gordon Kruse, Kathy Kuletz, Pat Lavin, Pat Livingston, Lloyd Lowry, Allen Macklin, Tom Malone, Suzanne Marcy, Michael H. Martin, Paul McCollum, Walter Meganack, Jr., Jennifer Nielsen, Gordon Nelson, Pat Norman, Phil North, Worth Nowlin, Peter Q. Olsson, Gretchen Oosterhout, Ted Otis, Paul Panamarioff, Kent Patrick-Riley, Charles Peterson, John Piatt, Josie Quintrell, Terry Reed, Stanley Rice, Evan Richert, Monica Riedel, George Rose, Dave Roseneau, Susan Saupe, Andy Schmidt, Carl Schoch, Sandra Schubert, Marianne See, Stan Senner, Bob Shavelson, Hugh Short, Jeff Short, Claudia Slater, Bob Small, Alan Springer, Stacy Studebaker, Arliss Sturgulewski, Joe Sullivan, Kevin Summers, Gary Thomas, Glenn VanBlaricom, Shari Vaughan, Gale Vicki, Jia Wang, Sarah Ward, Tom Weingartner, Steve Weisberg, David Welch, Kent Wohl, Bruce Wright, Kate Wynne.

OVERVIEW OF THE GEM DOCUMENT

The Gulf Ecosystem Monitoring (GEM) Program Document has been prepared in two volumes to more easily describe the basic monitoring and research program (Volume I) while providing access to the factual basis for the program (Volume II). Volume I explains the basic motivations for the program, information needs, and the strategies for meeting these information needs (see Table O.1 below). Volume II presents the factual basis for the program, including the detailed descriptions of two important components of the program: (1) modeling and (2) data management and information transfer. Table O.1 identifies the question addressed by each chapter and the products provided. The Overview Figure, following the table, illustrates the structure of the GEM Program Document.

Table O.1 Contents of the GEM Program Document

Chapter	Title & Question Addressed	Products
Volume I—Strategic Plan for Monitoring and Research		
1	Vision *Why do this and what do we hope to achieve?*	Mission and goals Program context
2	Human Uses and Activities *What are the human activities in the region and their potential impacts?*	Issues of concern to the Trustee Council and public
3	GEM Information Needs *What information do we need?*	Specific questions and information needs
4	Program Components and Strategies *How can we get the information we need?*	Key components and implementation strategies
5	Monitoring Plan & Research Agenda *What are we going to do to get the information, when will we do it, and with whom?*	Starting point for implementation process
6	Program Management *What are the processes and policies for monitoring and research?*	The Gulf Ecosystem Monitoring and Research Program
Volume II—The Historical Legacy: Building Blocks for the Future		
1	Building on Lessons of the Past *What do other regional marine science programs have to teach us?*	Past experience Hypotheses and strategies
2	Lingering Effects of the Oil Spill *What does experience from the oil spill teach us?*	Past experience
3	Scientific Background *What is published that can help us?*	Current knowledge of the Gulf of Alaska General research questions

Table O.1 Contents of the GEM Program Document

Chapter	Title & Question Addressed	Products
4	Conceptual Foundation *How do we think the ecosystem works?*	Central hypothesis and questions
5	Modeling *What is the role of modeling in GEM implementation?*	Modeling definitions and options for program implementation
6	Data Management and Information Transfer *What are the roles of data management and information transfer in GEM implementation?*	Data management and information transfer options for program implementation
A	Appendix A. Fish and Invertebrate Species from 1996 Trawl Survey of the Gulf of Alaska	
B	Appendix B. North Pacific Models of the Alaska Fisheries Science Center and Selected Other Organizations	
C	Appendix C. Gulf Ecosystem Monitoring and Research (GEM) Database	
D	Appendix D. Glossary of Existing Agency Programs and Projects	
E	Appendix E. Acronyms and Web Links	

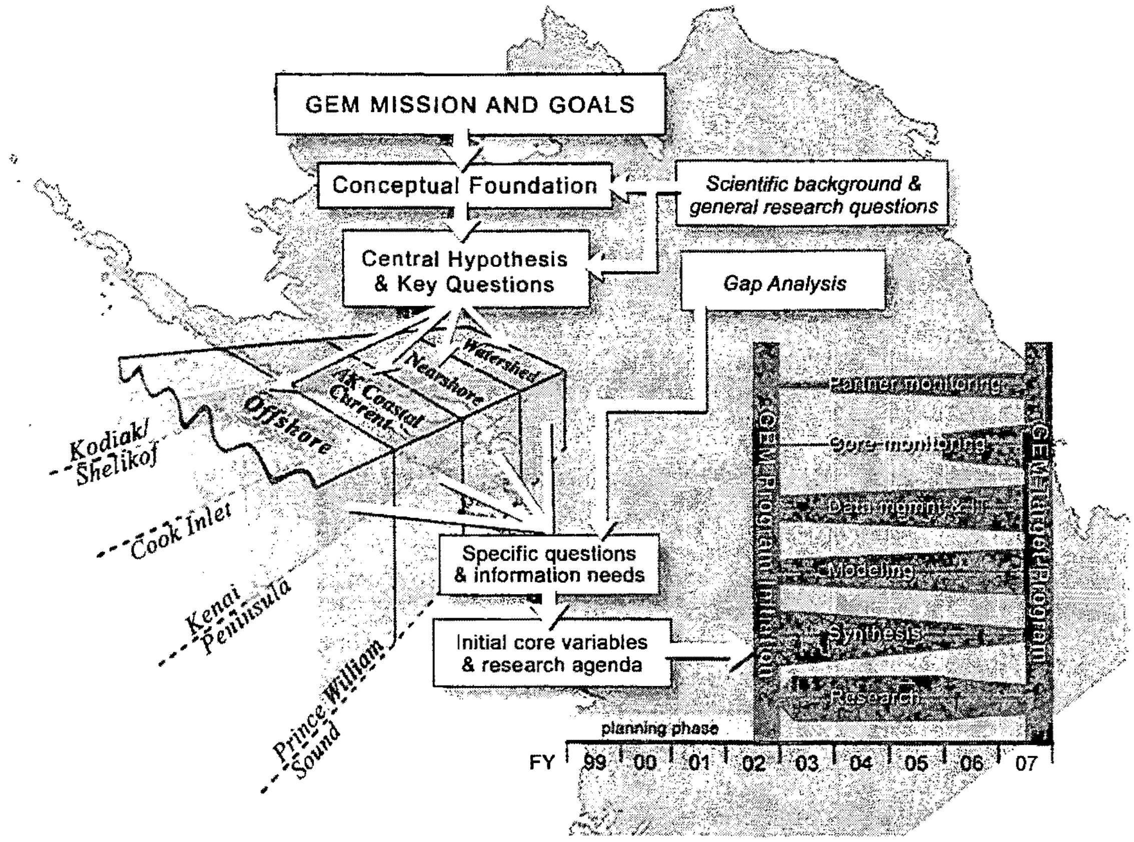


Figure O.1. An overview of the structure of the GEM program document showing the relation of key concepts to the habitat types and the schedule of implementation

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VOLUME II

Figures

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Appendices

1. VISION FOR GEM IN THE NORTHERN GULF OF ALASKA

In This Chapter

- Origin of the GEM program
- Explanation of the mission identified for the program
- Identification of goals, geographic scope, and funding

1.1 Introduction

A program rooted in the science of a large-scale ecological disaster is uniquely suited to form the foundation for ecosystem-based management. The knowledge and experience gained during 10 years of biological and physical studies in the aftermath of the *Exxon Valdez* oil spill (EVOS) confirmed that a solid historical context is essential to understand the sources of changes in valued natural resources. Toward this end, in March 1999 the *Exxon Valdez* Oil Spill Trustee Council (Trustee Council) dedicated approximately $120 million for long-term monitoring and research in the northern Gulf of Alaska (GOA). The new fund will be in place by October 2002 and will function as an endowment, with an annual program funded through investment earnings, after allowing for inflation-proofing and modest growth of the corpus.

In making the decision to allocate these funds for a long-term program of monitoring and research, referred to herein as the Gulf Ecosystem Monitoring and Research (GEM) program, the Trustee Council explicitly recognized that complete recovery from the oil spill may not occur for decades and that through long-term observation and, as needed, restoration actions, the injured resources and services are most likely to be fully restored. The Trustee Council further recognized that conservation and improved management of these resources and services would require substantial ongoing investment to improve understanding of the marine and coastal ecosystems that support the resources, as well as the people, of the spill region. Improving the quality of information available to resource managers should result in improved resource management. In addition, prudent use of the natural resources of the spill area without compromising their recovery requires increased knowledge of critical ecological information about the northern GOA. This knowledge can only be provided through a long-term monitoring and research program that will span decades, if not centuries. There are both immediate, short-term needs to complete

Prudent use of the natural resources of the spill area requires increased knowledge of critical ecological information about the northern GOA.

the understanding of the lingering effects of the oil spill and long-term needs to understand the sources of changes in valued natural resources.

1.2 Mission

The original mission of the Trustee Council's Restoration Program, adopted in 1993, was to "efficiently restore the environment injured by the EVOS to a healthy, productive, world-renowned ecosystem, while taking into account the importance of the quality of life and the need for viable opportunities to establish and sustain a reasonable standard of living."

Consistent with this mission and with the ecosystem approach to restoration adopted by the Trustee Council in 1994, the mission of the GEM program is as follows:

> ***Sustain a healthy and biologically diverse marine ecosystem in the northern Gulf of Alaska (GOA) and the human use of the marine resources in that ecosystem through greater understanding of how its productivity is influenced by natural changes and human activities.***

In pursuit of this mission, the GEM program will accomplish the following:

- Sustain the necessary institutional infrastructure to provide scientific leadership in identifying research and monitoring gaps and priorities;
- Sponsor monitoring, research, and other projects that respond to these identified needs;
- Encourage efficiency in and integration of GOA monitoring and research activities through leveraging of funds and interagency coordination and partnerships; and
- Promote local stewardship by involving stakeholders and having them help guide and carry out parts of the GEM program.

In adopting this mission, the Trustee Council acknowledges that, at times, sustaining a healthy ecosystem and ensuring sustainable human uses of the marine resources may be in conflict. In those instances, the goal of achieving a healthy ecosystem will be paramount. The Trustee Council also acknowledges that, at this time, clearly defined measures for assessing "ecosystem health" are lacking (NRC 2000). These measures will be incorporated into the program as they are developed.

1.3 Goals

Five major goals have been identified as necessary to accomplish the GEM mission. Attaining all five, however, will require several decades. Two of these goals may be attainable within the early decades of operating the GEM program, given sufficient funding and collaboration with other partners:

1. **Detect:** Serve as a sentinel (early warning) system by detecting annual and long-term changes in the marine ecosystem, from coastal watersheds to the central gulf; and

2. **Understand:** Identify causes of change in the marine ecosystem, including natural variation, human influences, and their interaction.

Two other goals provide an essential piece of the foundation for a long-term program. Although these goals are likely to be fully realized only after the first decade of operating the GEM program, shorter-term accomplishments should be achieved sooner:

3. **Inform:** Provide integrated and synthesized information to the public, resource managers, industry and policy makers in order for them to respond to changes in natural resources; and

4. **Solve:** Develop tools, technologies and information that can help resource managers and regulators improve management of marine resources and address problems that may arise from human activities.

The fifth goal is inherently long-term and difficult to achieve, but of considerable potential value to resource users and managers. It serves more as a long-range beacon to guide the design of monitoring activities, than as a goal that may be attained within the near term:

5. **Predict:** Develop the capacity to predict the status and trends of natural resources for use by resource managers and consumers.

During the process of learning how to detect and understand change in the northern GOA, resource managers and the concerned public should collect incremental dividends on their investment in GEM. The benefits, however, will be maximized over the long run. Ultimately, GEM must provide information that enables resource-dependent people, such as subsistence users, recreationalists, and commercial fishers, to better cope with changes in marine resources. The data and information produced by GEM during its first decade may not totally solve problems for the public, commercial interests, resource managers, and policy makers faced with environmental change. Nonetheless, as information accumulates, the ability for GEM to provide problem-solving information and tools can and must increase.

Given the size and complexity of the northern GOA ecosystem and the available funding, it will not be possible to meet these goals with only the data collected by GEM. Addressing the program goals will require achieving the following operational goals:

- **Synthesize** monitoring and research results to advise in setting priorities;

- **Prioritize** monitoring and research needs;

- **Identify** monitoring and research gaps currently not addressed by existing programs;
- **Fund** monitoring of core variables;
- **Leverage** funds to augment ongoing monitoring work funded by other entities;
- **Track** work of other entities relevant to understanding biological production in the GOA;
- **Involve** other government agencies, non-governmental organizations, stakeholders, policy makers, and the general public in a collaborative process to achieve the mission and goals of GEM; and
- **Facilitate** application of GEM research and monitoring results to benefit conservation and management of marine resources.

The substantial experience of the EVOS Restoration Program indicates that these eight operational goals are reasonable, necessary, and attainable.

1.4 Geographic Scope

Consistent with the Restoration Plan, GEM program activities will occur within the area affected by the 1989 oil spill, which is generally the northern GOA, including Prince William Sound (PWS), Cook Inlet, Kodiak Island, and the Alaska Peninsula (Figure 1.1). Recognizing that the marine ecosystems affected by the oil spill do not have discrete boundaries, some monitoring and research activities may extend into adjacent areas of the northern GOA.

Figure 1.1

THIS IS FIGURE 1 OF PREVIOUS REPORT. NEED THE ELECTRONIC FILE.

The primary geographic focus of GEM will be the four habitat types that contain the ecosystems of the area affected by the oil spill. Building on the lessons of the past from the oil spill damage assessment (Natural Resource Damage Assessment), the oil spill restoration program, and other efforts (see Volume II), monitoring will occur in localities within the habitat types best suited to answer the scientific questions posed in the GEM strategic plan (see Chapter 4, Volume I). Suitability of locales will be determined by scientific and policy criteria (Chapters 4 and 5, Volume I) that are designed in accordance with the mission and goals of the Trustee Council.

In defining geographic scope, it is also important to note that the ecosystems of the northern GOA encompass four habitat types–watersheds, intertidal and subtidal, Alaska Coastal Current (ACC), and offshore (the continental shelf break and the Alaska Gyre) (Section 3.1.2). Another important consideration is that the waters of the GOA are connected to adjacent waters. Waters from the shelf and basin of the GOA eventually enter the Bering Sea and the Arctic Ocean (through the Bering Strait). Although GEM has a regional (GOA) outlook, the program will be of vital importance in understanding the downstream Bering Sea and Arctic Ocean ecosystems. In addition to the linkages provided by the movements of ocean waters, the GOA is linked to other regions by the many species of birds, fishes, and mammals that also move through these regions. It is also becoming increasingly clear that environmental conditions in the GOA, such as levels of persistent organic pollutants, as well as the temperature of GOA waters, can originate many thousands of miles away.

1.5 Funding and Governance

The Trustee Council will fund the GEM program beginning in October 2002 with funds allocated for long-term monitoring and research, estimated to be approximately $120 million. The Trustee Council will manage these funds as an endowment, with the annual program funded by investment earnings after inflation-proofing, thus providing for a stable program through time. The Trustee Council also may choose to fund a smaller program in the early years to allow the corpus of the fund to build. The Trustee Council's long-term goal is to allow for additional deposits and donations to the fund from other sources to increase the corpus. Achieving this goal might require changes in state or federal legislation and possibly a change in the court-approved settlement and will be pursued at a later time.

Under existing law and court orders, three state and three federal trustees have been designated by the Governor of Alaska and the President of the United States to administer the restoration fund, which includes funding for GEM, and to restore the resources and services injured by the oil spill. The State of Alaska trustees are the Commissioner of the Alaska Department of Environmental Conservation, the Commissioner of the Alaska Department of Fish and Game, and the Attorney General. The federal trustees are the Secretary of the Interior, the Secretary of Agriculture, and the Administrator of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

The trustees established the Trustee Council to administer the restoration fund. The state trustees serve directly on the Trustee Council. The federal trustees each have appointed a representative in Alaska to serve on the Trustee Council. They currently are the U.S. Interior Department's Alaska Director of Fish Wildlife Service, the Alaska Director of the National Marine Fisheries Service, and the Supervisor of the Chugach National Forest for the Department of Agriculture. All decisions by the Trustee Council are required to be unanimous.

It is expected that the current Trustee Council will make policy and funding decisions for the GEM program. It has been suggested that at some time in the future, a new board or oversight structure other than the Trustee Council be established to administer or guide the GEM fund. It is also possible that an existing board, either under its current structure or with minor modifications, could take over management of the fund. Use of a new governance structure, if justified, would require changes in law and the applicable court decrees. Such changes would take considerable time and are not anticipated in the near future.

1.6 References

NRC. 2000. Ecological indicators for the nation. National Academy Press. Washington, D.C.

2. HUMAN USES AND ACTIVITIES IN THE NORTHERN GULF OF ALASKA

In This Chapter

- Discussion of the human impacts in the GOA
- Descriptions of sub-regions
- Identification of human activities occurring

NOTE: This chapter is being reworked, and part or all of it will be included in the Scientific Background, Chapter 3, Volume II.

The growing population of Alaska and the existing and potentially greater human use of the resources of the northern GOA are important considerations for development of GEM. To achieve the GEM mission of sustaining a healthy ecosystem, as well as sustaining human use of the marine resources of the GOA, it is essential to assess and understand the impacts that human activities may have on important fish and wildlife species, their habitat, and the northern GOA ecosystem overall.

The economy of Alaska depends heavily on extraction of natural resources, primarily oil, fish, and shellfish, followed by timber and minerals. In the northern GOA, commercial fishing, recreation, and tourism (including sport fishing), oil and gas development, logging, roadbuilding and urbanization, marine transportation, and subsistence harvests are all activities that have the potential to affect fish and wildlife populations and habitat.

The human impact on Alaska's marine ecosystems is relatively small, compared to impacts in most of the developed world. Other regions are faced with marine dead zones caused by eutrophication (decline of a water body caused by oxygen deficiency) from pesticide runoff; overfishing and depletion of fish stocks; serious industrial pollution; and degradation of important habitat such as coral reefs and coastlines. Alaska is pristine in comparison. Even here, however, natural resource managers have concerns about localized pollution, the potential impacts of some fisheries, extreme changes in some fish and wildlife populations, and the little known impacts of contaminants and global warming.

Even in pristine Alaska natural resource managers are concerned about the impacts of pollution on marine ecosystems.

State and federal laws and permitting systems are designed to identify and mitigate the direct impacts of these activities. Secondary and cumulative impacts are not as routinely assessed, however. There is concern that local problems, if left unidentified or unmonitored, could grow into regional problems.

Experience with the EVOS Restoration Program has demonstrated that, unless an impact is very large, it is often extremely difficult to isolate the human impact from the natural variability. Because GEM will be a long-term program, however, it is important to assess the potential impacts of human activities on a regular basis to determine their influence on changes in the abundance and distribution of important resources.

2.1 Socioeconomic Profile of the Northern Gulf of Alaska

About 71,000 full-time residents live within the area directly affected by the oil spill (Figure 1.1), and two to three times that number use the area seasonally for work and recreation. The spill area population, combined with that of the nearby population centers of Anchorage and Wasilla, totals 62% of the state's 627,000 permanent residents. When the resident population is combined with more than one million tourists who visit the state each year, it becomes clear that the natural resources of the northern GOA cannot be immune to the pressures associated with human uses and activities.

2.1.1 Prince William Sound

PWS lies north of the GOA and west of Cordova. About 7,000 people live and make their living in this area. The largest communities–Cordova, Valdez, and Whittier–are all coastal and predominantly non-Native, although Valdez and Cordova are home to Alaska Native village corporations and tribes. Chenega Bay and Tatitlek are Alaska Native villages. All five communities are accessible by air or water, and all have dock or harbor facilities. In the north, the ports of Valdez and Whittier link the area to the state's main road system.

The economic base of the five communities in PWS is heavily resource dependent. The Cordova economy is based on commercial fishing, primarily for pink and red salmon. As the terminus of the Trans-Alaska Pipeline System, Valdez is dependent on the oil industry, but commercial fishing and fish processing, government, and tourism also are important to the local economy. Large oil tankers routinely traverse PWS and the northern GOA to and from the Port of Valdez. In addition to working as oil industry employees, Whittier residents also work as government employees, longshoremen, commercial fishermen, and service providers to tourists. The people of Chenega Bay and Tatitlek augment commercial fishing, aquaculture, and other cash-based activities with subsistence fishing, hunting, and gathering.

2.1.2 Kenai Peninsula

The Kenai Peninsula, on the northwest margin of the GOA, separates Cook Inlet from PWS. The central peninsula is connected to the main road system, only a few hours by car from the major population center of Anchorage. Homer and Kenai have jet air access from Anchorage, and Whittier has train access, both passenger and cargo. Because of this road connection to Anchorage, the Kenai Peninsula is the fastest growing area in the northern GOA. About 50,000 people live on the peninsula, with about two-thirds living near the cities of Kenai and Soldotna. The economy of this area depends on the oil and gas industry, commercial fishing, and tourism. This area was the site of the first major Alaska oil strike in 1957 and has been a center for oil and gas exploration and production since that time. Seward is a seaport on the eastern Kenai Peninsula near the western entrance of PWS. It is the southern terminus of the Alaska Railroad, which transports marine cargo and passengers to and from Anchorage.

The southern Kenai Peninsula contains the cities of Homer and Seldovia and the Alaska Native villages of Nanwalek and Port Graham. Homer, on the north side of Kachemak Bay, is the southern terminus of the state's main road system on the peninsula. Seldovia, Nanwalek, and Port Graham, all located south of Kachemak Bay, are accessible only by air and sea. Nanwalek and Port Graham depend largely on subsistence hunting and fishing and on village corporation enterprises, such as the salmon hatchery, cannery, and logging enterprise at Port Graham. Homer is the economic and population hub of this part of the peninsula and depends on commercial fishing, tourism, and forest products.

Tourism is an important and growing part of the Kenai Peninsula economy. Marine sport fishing out of Seward and Homer is a major attraction for the tourist industry. Cruise ships dock at the Seward harbor, and commercial vessels take passengers on tours of the nearby Kenai Fjords National Park. The Kenai River and its tributary, the Russian River, are major sport fishing rivers, attracting tourists from Anchorage and all over the world.

2.1.3 Kodiak Island Archipelago

The Kodiak Island archipelago lies to the west of the northern GOA. This region includes the city of Kodiak and the six Alaska Native villages of Port Lions, Ouzinkie, Larsen Bay, Karluk, Old Harbor, and Akhiok. About 14,000 people live in this region, although the population swells in the fishing season. Communities on Kodiak Island are accessible by air and sea. Approximately 140 miles of state roads connect communities on the east side of the island.

The economy of the archipelago depends heavily on commercial fishing and seafood processing. Kodiak is one of the world's major centers of seafood production and has long been among the largest ports in the nation for seafood volume or value of landings. Village residents largely depend on subsistence hunting and fishing. Kodiak Island is also home to a commercial rocket-launch facility that held its first successful launch in 1999. The U.S. Coast Guard Station near Kodiak is a major landowner and employer.

2.1.4 Alaska Peninsula

The Alaska Peninsula is on the western edge of the northern GOA. Five communities on the south side of the Alaska Peninsula lie within the area affected by the EVOS: Chignik, Chignik Lagoon, Chignik Lake, Ivanof Bay, and Perryville. The population of the area is about 450 year-round residents, but doubles during the fishing season. All five communities are accessible by air and sea. The cash economy of the area depends on the success of the fishing fleets.

Chignik and Chignik Lagoon serve as regional salmon-fishing centers, and Dutch Harbor, southwest of Perryville and outside the spill area, is a major center for crab and other marine fisheries. In addition to salmon and salmon roe, fish processing plants in Chignik produce herring roe, halibut, cod, and crab. About half the permanent population of these communities is Alaska Native. Subsistence on fish and caribou is important to the people who live in Chignik and Chignik Lagoon.

Chignik Lake, Ivanof Bay, and Perryville are predominantly Alaska Native villages and maintain a subsistence lifestyle, relying on salmon, trout, marine fish and shellfish, crab, clams, moose, caribou, and bear. Commercial fishing provides cash income. Many residents leave during summer months to fish from Chignik Lagoon or work at the fish processors in Chignik.

2.1.5 Will add section on Anchorage Basin and how it affects other parts of region.

2.2 Description of Human Activities

2.2.1 Commercial Fishing

Commercial fishing is by far the predominant human activity in the northern GOA and is thought at this time to have the potential for the most significant impacts on the GOA ecosystem. Within the GOA, the major commercial fisheries are salmon, Pacific herring, pollock, cod, halibut, and shellfish. For the 2000 fishing season, within state waters, the total gross earnings for the GOA fishing activity were estimated to be about $127.5 million. Approximately 200 people fished, using a total of 2,900 permits. (Note: more information is needed in this paragraph.)

The period before the 1989 oil spill was a time of relative prosperity for many commercial fishermen. Since 1989, these drastic changes have occurred in the commercial fishing industry:

- Low prices have reduced the value of the pink and sockeye salmon fisheries.
- Sharp declines in herring populations in PWS, possibly caused by disease related to the EVOS, have resulted in closures that have devastated the fishery.

- The listing of the Steller sea lion under the federal Endangered Species Act has resulted in restrictions on groundfish fisheries.
- GOA crab stocks have continued their plummet.

A major ecological concern with all types of removals by fishing activities is the sustainability of fish stocks, which could be affected by directed fisheries or as a result of discarded bycatch in other fisheries and high seas interception. Overfishing could lead to stock depletion. The predominant fishery stocks historically fluctuate because of natural variability and climate cycles. Setting harvest rates without a complete understanding of those fluctuations could lead to unintentional overharvest, resulting in population declines that could take years to rebound.

Another ecological concern with all types of fishing is the removal of marine nutrients (nitrates, phosphates, iron) that are key to sustaining the long-term productivity of watersheds (Finney et al. 2000). Fishing for a dominant anadromous species such as salmon may lower the productive capacity of a watershed not only for salmon, but for a wide range of plants, fish, and mammals that are known to depend on marine nutrients. When combined with the loss of nutrients associated with development of riparian (river and other waterfront) habitats and wetlands, the loss of marine nutrients may contribute to the process known as oligotrophication or "starvation" of the watershed. Unfortunately, not enough monitoring data on marine nutrients in tributaries of the GOA is available to understand the degree to which oligotrophication is occurring.

A third ecological concern with fishing is the potential for degradation of habitats, and attendant losses of unintended species. Sport-fishing activities in watersheds have substantially degraded some riparian habitats in Southcentral Alaska, resulting in lost vegetation, lost fish habitat, and siltation. Various types of marine fishing methods and gear, such as pots and hard-on-bottom trawls (baglike nets), also have the potential for degrading sea-bottom habitat and reducing populations of sedentary species such as corals and seaweeds.

Protection has already been afforded to marine habitats in some cases by excluding gear types that are thought to be injurious to habitat. For example, the eastern GOA is now closed to trawling and dredging in part to protect coral habitats from possible trawling impacts. In addition there are numerous trawl-and-dredge closure areas near Kodiak Island, the Alaska Peninsula, and the Aleutian Islands. Areas where marine mammals feed and that are adjacent to their haul-out areas also have been closed to commercial fishing in parts of the Bering Sea, Aleutian Islands, and GOA. Given the amount of marine habitats already subject to closure, more information on how to define critical marine habitats, a possible role for GEM, is essential to balancing fishing opportunities and protection of habitat. (Need to add impacts of drift nets.)

More information on how to define critical marine habitats is essential to balancing fishing opportunities and protection of habitat.

Commercial fishing also has the potential to affect other elements of the marine ecosystem, such as bird and marine mammal populations. Effects result either directly, through entanglement in fishing nets or disturbance to haul-outs and rookeries, or indirectly, through impacts on food supplies. A recent National Marine Fisheries Service (NMFS) Biological Opinion concludes that lack of food is the reason why the endangered Steller sea lion is not recovering from serious declines in the GOA and Bering Sea. On the basis of this opinion, NMFS has severely limited fixed-gear and trawl fishing for several groundfish species, a major food source for the Steller sea lion.

Salmon fisheries in the GOA are notable because hatcheries produce the majority of some salmon species in some areas and, in specific fisheries, the majority of salmon harvested. Billions of juvenile salmon are released annually from hatcheries in three areas within the northern GOA: Cook Inlet, Kodiak, and PWS. Within this region, 56% of the salmon in the traditional commercial harvest were of hatchery origin in 1999. The percentage is higher if cost-recovery fisheries are also included. In PWS in particular, hatchery production provides a majority of the pink and chum salmon harvested and a substantial fraction of the sockeye and coho salmon harvested. In 1999, hatchery pink salmon contributed 84% of the number of pink salmon harvested by commercial fisheries in PWS.

Information on the interactions between hatchery and wild fish appears to be essential to long-term fishery management programs.

Ecological concerns related to hatcheries include reduced production of wild fish because of competition between hatchery and wild salmon during all stages of the life cycle, loss of genetic diversity in wild salmon, and overharvest of wild salmon during harvest operations targeting hatchery salmon. Information on the interactions between hatchery and wild fish in specific locations, and on the impact of salmon produced in hatcheries in both Asia and North America on food webs in the GOA, appears to be essential to long-term fishery management programs.

2.2.2 Recreation and Tourism

Major recreational and tourist attractions within the spill area include Portage Glacier, Kenai Fjords National Park, Columbia Glacier, Kachemak Bay, and Katmai National Park. World-class salmon fishing attracts residents and visitors alike to the Kenai River, the Russian River, and other rivers on the Kenai Peninsula. Charter halibut fishing is an important and growing recreational activity, especially for Seward and Homer. More than 500 vessels are active in this industry. Camping, hiking, kayaking, and wildlife viewing attract visitors to the Kodiak Island National Wildlife Refuge, the Chugach National Forest, and numerous state and federal park units and refuges within the spill area.

Growth of the Alaska population and increases in nonresident visitation to Alaska will increase the potential impacts of GOA resource use. Between 1990 and 1998 alone, the number of nonresident visitors to Alaska increased from 900,000 to 1.35 million per year, averaging a 5% annual rate of increase during this period.

Cruise ship traffic to the state has been increasing by more than 10% a year, although the rate may be slowing somewhat.

Increased tourism and recreational use could result in a variety of impacts on marine fish and wildlife and their habitats. Sport fishing could contribute to localized depletion of fish stocks, as well as degradation of streambank habitat in watersheds. Increased recreational boat traffic can disturb wildlife on their rookeries and haul-outs, as well as increase oil and gas residue in harbors and adjacent waters. Cruise ships often carry more people than populate many Alaska towns, and cause concerns about their disposal of garbage and other waste, impacts on air quality, and potential for diesel fuel spills. The growing use of jet skis for recreational use and their potential for disturbing nesting waterfowl has led to a jet ski ban in Kachemak Bay by the Alaska Department of Fish and Game (ADF&G). Increased hiking and camping on coastal areas and riverbanks can lead to trampling, erosion, and related impacts on local water quality. The Whittier road, opened in 2000, is expected to increase visitation to northwestern PWS, with potential impacts to shorelines, tidelands, and nearshore waters, as well as the fish and wildlife populations that rely on these habitats.

2.2.3 Oil and Gas Development

The oil and gas industry is a major economic force in PWS and Cook Inlet. Crude oil pumped from fields on the North Slope is transported by pipeline to Valdez, where it is loaded onto tankers and shipped to the lower 48 states. Tankers traverse PWS on the journey south. The number of tanker voyages from the Port of Valdez has declined from 640 in 1995 to 411 in 1999, because of the sharp reduction in North Slope crude oil production. Any additional North Slope development could increase tanker traffic.

Discovered in 1957, the Swanson River oilfield in the Kenai National Wildlife Refuge is the site of the first commercial oil development in Alaska. Much of the oil and gas development in the Cook Inlet area occurs on offshore platforms. Underwater pipelines transport product to terminals on both sides of Cook Inlet. Tankers ship crude oil and refined product to the lower 48 states.

In April 1999, the State of Alaska offered for lease all available state-owned acreage (approximately 2.8 million acres) in its first Cook Inlet Areawide Oil and Gas Lease Sale. As a result of the first sale, oil and gas leases have been issued on about 115,000 acres of land. Sales in August 2000 and May 2001 resulted in the lease of about 205,000 acres of land. Additional sales are planned in 2002 and 2003.

The major concerns about oil and gas development include the potential for oil spills from vessel traffic, as happened during the 1989 EVOS, as well as small, chronic spills, pipeline corrosion and subsequent leaks, disposal of drilling wastes and potential impact on water quality, and the introduction of exotic species from ballast waters. In 1995, local conservation groups negotiated a settlement with

Cook Inlet oil and gas producers for more than 4,000 violations of the federal Clean Water Act in Cook Inlet.

The State of Alaska issues permits and leases that stipulate site- and activity-specific mitigation measures, and provide for monitoring of production, transport, and exploratory activities on state land and waters. (The Minerals Management Service is responsible for comparable federal regulation of offshore development under the Outer Continental Shelf Act) For activities within federal jurisdiction, the National Environmental Protection Act provides for analysis of environmental oil and gas development impacts. All oil producers, shippers, and refineries are required to have approved contingency plans detailing response capabilities and specific response actions in the event of a spill. In addition, the Oil Pollution Act of 1990 created the regional citizens advisory groups to oversee oil and gas activities in PWS and Cook Inlet.

2.2.4 Subsistence Harvest

Fifteen predominantly Alaska Native communities in the GEM region, with a total population of about 2,200 people, rely heavily on harvests of subsistence resources such as fish, shellfish, seals, deer, and waterfowl. Subsistence harvests in 1998 varied among communities from 250 to 500 pounds per person, indicating strong dependence on subsistence resources. Subsistence activities also support the culture and traditions of these communities. Many families in other communities also rely on the subsistence resources of the spill area.

Subsistence use is a form of resource exploitation and must be considered as a factor potentially affecting resource abundance and distribution. It is monitored under state and federal authorities. Subsistence harvest of marine mammals is probably of greatest concern because marine mammals are an important component of subsistence diets in the GEM region and because subsistence harvests are the only legal take of marine mammals, have no regulatory restrictions, and may affect species with small populations.

2.2.5 Timber Harvest

No major timber operations are currently occurring in PWS, but logging continues on Afognak Island in the Kodiak archipelago and small-scale timber operations are planned for parts of the Kenai Peninsula. Of the three major logging operators on Afognak Island, only Afognak Native Corporation is still logging in a major way, with 30 million board feet in 2000 and another 30 million board feet planned for 2001. Poor lumber markets, increased competition, and a dwindling timber supply have all led to decreased logging activities on Afognak. Logging operations on Port Graham Corporation lands on the southern Kenai Peninsula have concluded, but some logging may take place on Native allotments near Port Graham. On the Alaska Peninsula, Ninilchik Native Corporation and Cook Inlet Region Inc. are preparing a major logging operation to begin in 2001 on the Crescent River, a major salmon producer in Cook Inlet.

The State of Alaska has a five-year Schedule of Timber Sales for the Kenai Peninsula and Kodiak area from 2000 through 2004. One significant factor affecting forest planning in the Kenai area is a major epidemic of the spruce bark beetle. The proposed timber sales are designed to use dead and dying timber or to harvest timber with a high likelihood of infestation in the next few years. During this 5-year period, the state plans to hold 31 timber sales on about 23,000 acres of state land on the Kenai Peninsula. Harvest from these lands is estimated to be 115 million board feet of spruce and hemlock and 410,000 cubic board feet of birch, cottonwood, and aspen. In 1999 in the Moose Pass area, one sale that totaled 153 acres occurred. In December 2000, three tracts in the Ninilchik/Clam Gulch area, totaling 1,604 acres, were re-offered; however, no bids were received.

Concerns about logging include water quality effects, long-term effects on the marine system of bark from log transfer facilities, and impacts on anadromous streams from siltation and habitat destruction. The Alaska Department of Environmental Conservation (ADEC) reported that 24% of the water bodies on the state's list of polluted sites are due to some aspect of logging. (ADEC 2000, ADEC et al. 2001) A significant issue related to logging is the increased access to previously remote lands provided by logging roads. Logging operations on the Kenai Peninsula alone have added more than 3,000 miles of roads in the region. This increased access has encouraged all-terrain vehicle use in sensitive habitats, such as the headwaters of salmon streams.

2.2.6 Other Industrial Activity

Large spills like the EVOS are rare. More common are smaller discharges of refined oil products, crude oil, and hazardous substances. Small spills have been caused by a variety of industries, such as oil and gas, timber, fishing, and seafood processing industries, as well as small commercial establishments such as gas stations and dry cleaners.

Under state law, the release of hazardous substances and oil must be reported to ADEC. In 1998 and 1999, 1,325 spills were reported in the EVOS region, resulting in a total discharge of 218,000 gallons of refined oil products, crude oil and hazardous substances. Although small spills were reported throughout the spill area, by far the largest number of spills (1,037) and greatest volume of discharge (198,000 gallons) occurred in the Cook Inlet region. Most spills (87%) involved refined oil products; these spills accounted for about 90% of the total volume discharged. Only 6,000 gallons of crude oil were reported spilled in the region from 1998 to 1999 (ADEC 2001).

Figures reported to ADEC include spills onshore as well as discharges into the marine environment. The effects of these small spills depend on such variable factors as the volume of the discharge, its toxicity and persistence in the environment, the time of year the spill occurred and the significance of the affected environment in the life history of species of concern.

2.2.7 Road Building and Urbanization

Community growth and urbanization often go hand in hand with loss of water quality and fisheries habitat. The greatest concentration of roads, subdivisions, and other aspects of increased urbanization affecting the GEM region are within the Municipality of Anchorage and on the west side of the Kenai Peninsula. **In Anchorage (need more information).** In 1999, the Kenai Peninsula Borough approved plats for 250 subdivisions. Most of the subdivisions were small, but a few were 40 acres or more. The borough recently initiated a road-permitting program that will address placement and design of new roads.

Continued expansion of urban areas and resulting expansion of suburban zones inevitably degrade habitat. Changes in land surfaces can change entire hydrologic systems and add to water pollution problems. Urban growth leads to increasing disposal of human wastes. Even treated wastes may lead to changes in species composition and productivity in watersheds, estuaries, and nearshore areas.

Increased areas of impervious surfaces through new roads and subdivisions usually increase stormwater runoff. Stormwater runoff is the largest single source of pollution in Alaska and is caused by runoff and erosion from pavement, parking lots and ditches, commercial and residential construction, and septic systems. Thirty-eight percent of the sites on a 1998 state list of polluted water are affected by such community runoff. The pollutants include chemicals, bacteria, and excess soil.

Increased stormwater runoff tends to lower base flows in streams and increase peak flows. Stream macroinvertebrates (large animals that lack backbones) and fish populations are sensitive to these changes. As part of its stormwater discharge permit through ADEC, the Municipality of Anchorage is mapping the impervious surfaces within its area and studying the response of stream macroinvertebrates. Under a U.S. Environmental Protection Agency (EPA) 319 grant from ADEC, the U.S. States Department of Agriculture Cooperative Extension Service is also studying the effects of impervious surfaces. A pilot project is planned for the Anchorage area, and if successful, the methodology may be applied to other areas in the future.

Increased urbanization also results in filling wetlands, which play an important ecological role in filtration for water quality and stormwater protection. The Municipality of Anchorage has a wetlands plan, with high- and low-value wetlands identified. There is no plan delineating the extent of wetlands and analyzing their function and values for the rest of the region, however.

Human access to streams usually leads to degradation of aquatic habitat.

Human access to streams increases as the number of miles of road increases. Trampling of stream banks, changes in stream configuration created by culverting of roads, reduction in riparian zone vegetation, and a multitude of other problems created by road building and access lead to aquatic habitat degradation and loss of basic productivity. Increased human access to small rivers and streams containing relatively large animals such as salmon and river otters also usually leads to loss of aquatic species through illegal taking, despite the best efforts of law enforcement. Indeed, limitations in budgets usually lead resource management and protection agencies to focus scarce resources on sensitive areas during critical seasons, leaving degradation to take its course in less sensitive locations.

2.2.8 Contaminants and Food Safety

The presence of industrial and agricultural contaminants in aquatic environments has resulted in worldwide concerns about potential effects on marine organisms and on human consumers. Polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and organochlorine pesticides, such as dichlorodiphenyltrichloroethane (DDT) and its derivatives, are distributed around the world in marine and coastal waters and in the rivers and watersheds that feed fresh water into these environments. Such pollutants can be transported great distances by winds and ocean currents following their releases from industrial and agricultural sources, most of them far from Alaska. In addition, mercury and other metals, such as inorganic arsenic, cadmium, and selenium, are naturally present in the environment at low concentrations, but man-made sources can contribute additional quantities to the environment.

The remoteness of the northern GOA from centers of industry and human population might be expected to protect much of this region from deposition of environmental contaminants. Nonetheless, there is limited evidence suggesting wide geographic distribution of persistent organochlorines (DDT, dichlorodiphenyldichloroethylene [DDE], PCB), other organic pollutants and heavy metals in the Arctic, Subarctic, and areas adjacent to the GOA (Crane and Galasso 1999). For example, measurable amounts of organochlorines have been found in precipitation, and fishes of the Copper River Delta, a tributary of the GOA that forms the eastern boundary of PWS (Ewald et al. 1998).

A variety of geophysical pathways bring these materials into the GOA, including ocean currents and prevailing winds. In particular, the prevailing atmospheric circulation patterns transfer various materials as aerosols from Asia to the east across the North Pacific (Pahlow and Riebsell 2000) where they enter the marine environment in the form of rain. Some of these contaminants, such as PCBs and DDT, can bioaccumulate in living marine organisms. For example, research sampling of transient killer whales that had eaten marine mammals in PWS indicated concentrations of PCBs and DDT derivatives that are many times higher than those concentrations found in fish-eating resident whales. The sources of these contaminants are not specifically known. It has been established, however, that these contaminants are passed from nursing female killer whales to their calves.

There is also concern about the potential effects of contaminants on people, especially those who consume fish and shellfish, waterfowl, and marine mammals.

At higher levels of exposure, many of the chemicals noted above can cause adverse effects in people, such as the suppression of the immune system caused by PCBs.

The State of Alaska does not monitor environmental pollutants in the marine environment or in marine organisms on a regular basis. There is no ongoing program for sampling food safety in subsistence resources in coastal communities, although the oil spill provided the opportunity to sample subsistence resources for hydrocarbons in the affected areas from 1989 through 1994. Federal funding for a joint federal-state-Native initiative has been requested from Congress. NOAA has annually measured chemicals in mollusks and sediments since 1984. The agency also has monitored chemical concentration in the livers of bottom-dwelling fish and in sediments at the sites of fish capture since 1984. The Prince William Sound Regional Citizens Advisory Council has measured hydrocarbon concentrations and sources within areas of PWS and the GOA. This program focuses on sampling of intertidal mussels and nearby sediments.

2.2.9 Global Warming

Although driven by forces outside the control of Alaska's natural resource managers, global warming is an essential consideration for development and implementation of the GEM program. The earth's climate is predicted to change because human activities–the combustion of fossil fuels and increased agriculture, deforestation, landfills, industrial production, and mining–are altering the chemical composition of the atmosphere through the buildup of greenhouse gases. These gases are primarily carbon dioxide, methane, and nitrous oxide. Their heat-trapping property is undisputed, as is the fact that global temperatures are rising. Observations collected during the last century suggest that the average land surface temperature has risen 0.45° to 0.6° C. Precipitation has increased by about 1% over the world's continents in the last century, with high-latitude areas tending to see more significant increases in rainfall and rising sea levels. This increase is consistent with observations that indicate the northern GOA seasurface temperature has increased by 0.5° C since 1940, and that precipitation in Alaska (excluding the panhandle) increased 11% from 1950 through 1990.

Increasing concentrations of greenhouse gases are likely to accelerate the rate of climate change. The changes seen in the northern GOA and their relationship to other warming and cooling cycles in the North Pacific and the combined effects on global climate are important for understanding how humans affect biological production. Some populations of fish and marine mammals that show longtime trends, up or down, or sharp rapid changes in abundance, are actively managed through harvest restraints. The extent to which harvest restraints may be effective in establishing or altering trends in abundance of exploited species can only be understood within the context of climate change.

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3. INFORMATION NEEDS

In This Chapter

- Summary of general gaps in marine science
- Definition of the central question in terms of the four main habitat types integral to the GEM program
- Starting points for development of information needs for each habitat type

3.1 Introduction

Appendix C summarizes the database of current and historical monitoring and research projects in the GOA and adjacent waters, and highlights a number of data sets that will be of great value in developing the GEM program. This chapter provides a "gap analysis" of information needed to answer the key questions of the conceptual foundation described in Volume II, Chapter 4. Those questions are designed to promote better understanding of the origins and time-space scales of variability in marine production and fluctuations of key marine-related species in the GEM region. The questions, and information needed to answer them, are still very broad. To provide a more meaningful gap analysis, the key questions have been further expanded into multiple specific questions for each of the four representative habitat types: watersheds, intertidal-subtidal, Alaska Coastal Current (ACC), and offshore. The specific questions are then followed by a description of the information needed to answer them. Critical ecological processes are also suggested for each habitat type to provide further context for the specific questions and information needs. Together, these information needs will form the starting point for developing specific hypotheses and designing the monitoring and research components necessary to test them as described in Chapter 5 (Volume I).

The reader is advised to consider the questions and information needs below as the starting points for the process of implementation. All concepts for specific information needs are subject to further development through the scientific advisory process described in Chapter 6 (Volume I). The advisory process is expected to include workshops and other meetings to gather the advice of experts in science, public policy, management, and user group concerns. Opportunities for data acquisition and partnerships are discussed in Chapter 5 (Volume I).

3.1.1 General Information Gaps in Marine Science

Relatively little information has been gathered for species of plants and animals that are physically small and unsuitable for commerce and subsistence (see Appendix C). Consequently, substantial information gaps still exist for the basic life histories and biology of broad assemblages of species and communities that are outside the realm of human trade. The rule of thumb is that the amount of scientific information available is inversely proportional to the remaining energy and biomass at each trophic level. **(Need xc figure here)** An especially large gap exists for basic information on zooplankton species and benthic invertebrates that provide a vital link between primary producers and fish, birds, and mammals that constitute the higher trophic levels. Additionally, how natural forces and human activities control productivities of valued living marine resources is still poorly understood, although information on the natural forces of climate and physical oceanography is steadily increasing primarily through satellite telemetry.

3.1.2 Representative Habitat Types

Four habitat types, representative of the GEM region, are used to better organize the GEM program: watersheds, the intertidal-subtidal areas, the ACC, and the offshore areas (the continental shelf break and the Alaska Gyre). These habitats are composed of identifiable, although not rigid, collections of characteristic microhabitats, resident and migratory species, and physical features. The physical locations are described below:

- Watersheds–freshwater and terrestrial habitats from the mountains to the extent of the rivers' plumes;
- Intertidal-subtidal areas–brackish and salt-water coastal habitats that extend offshore to the 20-m depth contour;
- ACC–a swift coastal current of lower salinities (25 to 31 psu) typically found within 35 km of the shore; and
- Offshore–the continental shelf break (between the 200-m and 1,000-m depth contour) and the Alaska Gyre in waters outside the 1,000-m depth contour.

3.1.3 The Central Question by Habitat Types

The central question (Chapter 4, Volume II) seeks fundamental understanding of the degree to which changes in production of plants and animals in the four habitat types of GEM are controlled by natural environmental forces as opposed to human activities:

> ***What are the relative roles of natural forces and human activities, as distant and local factors, in causing short-term and long-lasting fluctuations changes in the biological communities that support birds, fish, shellfish, and mammals in the four key habitats of the GOA?***

To identify the information needed in each habitat type, the central question is adapted to the habitat's circumstances in the following sections. Information needs are identified as the answers to specific forms of the central question for each habitat type.

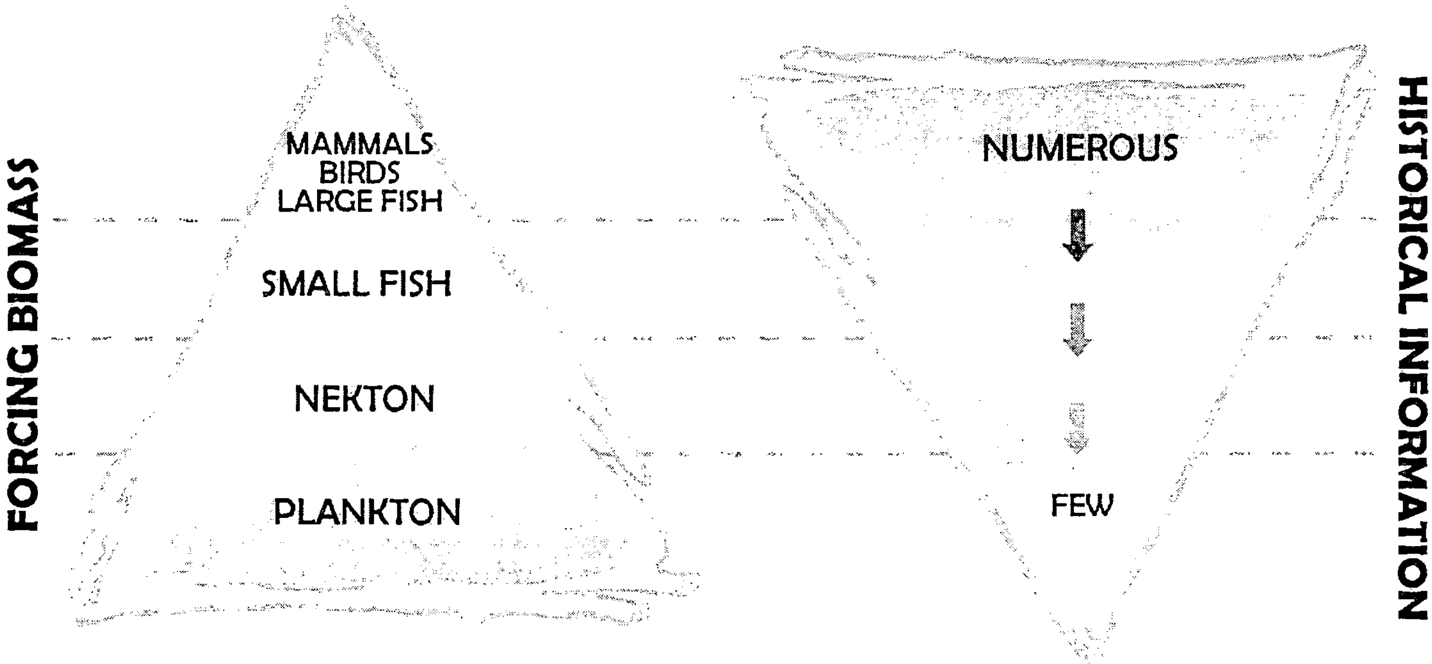
FORCING BIOMASS
MAMMALS
BIRDS
LARGE FISH
SMALL FISH
NEKTON
PLANKTON
NUMEROUS
FEW
HISTORICAL INFORMATION

figure xc

3.2 Watersheds

3.2.1 General Watershed Information Needs

The key question for watershed habitats is:

What are the relative roles of natural forces, such as climate, and human activities, such as habitat degradation and fishing, as distant and local factors, in causing short-term and long- lasting changes in marine-related biological production in watersheds?

Long-term monitoring of marine-related productivity in watersheds is needed before the long-term effects of human activities and other natural forces on productivity can be understood. Current monitoring activities and historical records make it possible to detect changes in productivity of prominent species within watersheds that are subject to relatively high levels of human activities, such as the Kenai River. Understanding the causes of changes is not possible; however, because a lack of basic measurements prevents separating the effects of changes in marine productivity from the effects of other factors such as human activities and natural biological and geological forces. Evidence of the significant role of marine nutrients in determining the productivity of watersheds is growing; however, monitoring of these linkages in the northern GOA is nonexistent to weak, based on the information gathering projects described in the database (see Appendix C). Measurements of certain kinds of human activities such as land development and fishing in watersheds are widely available, but the actual impacts of these activities on production of natural resources are less certain. Cumulative impacts such as accumulation of persistent contaminants may be of interest at some point in the future as they relate to control of plant and animal production.

In addition, although there is substantial evidence of the potential role of the micronutrient iron in controlling marine productivity, the degree to which watersheds may be contributing iron to marine food webs in the GOA is not being measured. The nature of flows of marine nutrients into watersheds, and the flow and distribution of freshwater micronutrients (such as iron), and carbon from the watersheds into the marine environments remain poorly understood in the GOA. Filling watershed information gaps would address long-term questions about how the transport of marine nutrients, terrestrial micronutrients, carbon, and fresh water contribute to changes in productivity and community structure in watersheds and the marine environment.

3.2.2 Specific Watershed Questions and Information Needs

Three specific watershed(W) questions and the related information needs are presented below.

W-1. What are levels of marine-related nutrients in watersheds and how do the annual inputs of marine nutrients vary?

Specific Information Needs: Levels of nitrogen-stable isotopes in freshwater plants and animals, and feasibility of studying sources of precursors of reduced iron in watersheds with marine access.

W-2. What is the annual variability in precipitation and runoff in Alaska watersheds bordering the northern GOA? (Same question applies to intertidal-subtidal and ACC habitats.)

Specific Information Needs: Annual precipitation and runoff for all watersheds flowing into the northern GOA. In some cases, where gaps exist, it may be possible to use marine salinity data to supplement precipitation and stream flow measures in estimating total freshwater run off from land to the GOA. Input of the amount of fresh water entering the GOA from northern British Columbia and Southeast Alaska would also be needed to use marine salinity as a proxy for freshwater runoff.

W-3. What are the levels of persistent contaminants entering and leaving watersheds along marine-related pathways?

Specific Information Needs: Levels of persistent organic pollutants such as PCBs in anadromous species as adult immigrants and as juvenile emigrants of the watersheds.

3.2.3 Watershed Processes

The watershed processes identified as of interest to the GEM program are those involved in linkages between terrestrial and marine variability, such as biogeochemical cycles.

3.3 Intertidal and Subtidal

3.3.1 General Intertidal and Subtidal Information Needs

The key question for intertidal and subtidal habitats is:

What are the relative roles of natural forces, such as currents and predation, and human activities, such as sediment and pollutant discharge, as distant and local factors, in causing short-term and long-lasting changes in community structure and dynamics of the intertidal and subtidal habitats?

Long-term monitoring is needed to identify how human activities can change the community structure of the intertidal and subtidal areas. Current monitoring activities may make it possible to detect changes in community structure that are the result of a combination of human activities and natural forces in some localities; however, no program now produces the measurements sufficient to determine the extent to which such changes are due to human activities. Evidence of the increasingly important role of human activities in changing the community structure of shallow nearshore environments is growing; however, monitoring that is structured to separate human and natural effects in areas of growing human impacts is sporadic. Monitoring is needed to measure the natural variability of the intertidal-subtidal areas at places and times that support detection of the effects of human activities. Simultaneous monitoring of currents and nutrients, bottom substrates, species composition, and other important natural forces in areas with differing degrees of chronic human activity is needed. Filling intertidal-subtidal information gaps would begin to address the long-term questions of how human activities combine with natural forces to cause changes in productivity and community structure in intertidal-subtidal environments.

3.3.2. Specific Intertidal and Subtidal Question and Information Needs

One specific intertidal and subtidal (I) question and several related information needs are presented below.

I-1. What is the variability of selected plant and animal populations in the intertidal and subtidal zones?

Specific Information Needs:

- Variability in numbers and diversity of fixed algae and invertebrates in several regions: PWS, Kachemak Bay, and Kodiak Island.
- Relative availability of larval dispersal stages.
- Measures of the cycling of carbon, nutrients, and contaminants in key species such as *Fucus*.
- A detailed map of intertidal plant biomass during the growing season on a wide spatial scale.
- Monitoring of clam populations.
- Measurements of population processes of sea otters.
- Identification and measurement of human impacts of concern.

3.3.3 Intertidal and Subtidal Processes

Processes in the intertidal and subtidal habitat of interest to the GEM program relate to variability in community structure and plant biomass of selected populations and processes affecting populations.

3.4 Alaska Coastal Current

3.4.1 General ACC Information Needs

The key question for ACC habitats is:

What are the relative roles of natural forces, such as the variability in the strength, structure and dynamics of the ACC, and human

activities, such as fishing and pollution, in causing local and distant changes in production of phytoplankton, zooplankton, birds, fish and mammals?

Long-term monitoring activities to detect seasonal changes in the ACC have permitted a general, large-scale understanding of circulation and lower trophic level productivity in the ACC, but current monitoring does not permit the changes in the ACC to be related to the changes in community structure or productivities in intertidal-subtidal areas and watersheds. Long-term monitoring is needed to measure the natural seasonal and interannual variability of the ACC at locations that are likely to permit evaluation of these relationships. Changes in annual production of some fish stocks are highly correlated with physical changes in the ACC, but ideas about the basis for these apparent relations cannot be evaluated from current monitoring activities. Filling ACC information gaps would begin to address the long-term questions of how human activities combine with the transport of marine nutrients, terrestrial micronutrients, carbon, and fresh water to contribute to changes in productivity and community structure in watersheds and the marine environment.

3.4.2 Specific ACC Questions and Information Needs

Seven specific ACC (A) questions and related information needs are presented below.

A-1. What is the annual variability of strength, location and dynamics of the ACC?

Specific Information Needs: Measurements of variability in temperature and salinity with depth, on time scales of from days to multiple decades at locations sufficient to understand seasonal-scale variability at localities sufficiently widely dispersed to understand large-scale structure, including intrusion into bays.

A-2. What is the variability in the supply of deepwater nutrients to the photic zone of the ACC and their concentrations in that zone on time and space scales appropriate to understanding annual primary production?

Specific Information Needs: Measurements of, or proportional to, macronutrients and micronutrients at appropriate spatial scales.

A-3. What is the variability in chlorophyll a concentrations and phytoplankton species composition in the photic zone of the ACC on time and space scales appropriate to understanding annual primary production?

Specific Information Needs:

- Chlorophyll a measurements.
- Information on phytoplankton species composition.

A-4. What is the variability of zooplankton biomass and species composition in the ACC on time and space scales appropriate to understanding annual primary and secondary production?

Specific Information Needs: Information about zooplankton biomass and species composition.

A-5. What is the variability in the availability of forage fish to higher trophic levels (birds, fish, mammals) in the ACC?

Specific Information Needs:

- Analyses of the diets of selected higher-trophic-level organisms (birds, mammals, large predatory fish).
- Analyses of selected higher-trophic-level organisms (birds, mammals, large predatory fish) for fatty acid composition in relation to diet.

A-6. What are the major factors affecting long-term changes in sea bird populations?

Specific Information Needs: Annual colony and chick productivity counts of appropriate species in selected GOA colonies.

See also information needs for Question A-5 above.

A-7. What are the major factors affecting long-term changes in harbor seal populations?

Specific Information Needs:

- Annual surveys of molting population in selected GOA haul-outs.
- Fatty acid profiles of individual animals and scat analysis surveys in selected GOA haul-outs.

3.4.3 Alaska Coastal Current Processes

Processes in the ACC of interest to the GEM program relate to variability in the current structure and dynamics, nutrient supply, and selected populations and processes affecting populations.

3.5 Offshore: The Outer Continental Shelf and Oceanic Waters

3.5.1 General Offshore Information Needs

The key question for offshore habitats is:

What are the relative roles of natural forces, such as changes in the strength of the Alaska Current and Alaskan Stream, mixed layer depth of the gyre, wind stress and downwelling, and human

activities, such as pollution, in determining production of carbon and its shoreward transport?

Long-term information gathering is needed on the effect of the open ocean gyre on the natural variability in seasonal and annual productivity of the continental shelf and ACC. Past information gathering is sufficient to suggest that a strong relationship between gyre and inner waters has existed at times. The gyre-continental shelf-ACC relationship appears to be based on movement of nutrients–detritus and plankton. Current information gathering, however, does not provide the long-term data sets needed to detect changes in the gyre that may be related to changes in the ACC, intertidal-subtidal areas, or watersheds. The same changes in annual production of certain fish stocks that are highly correlated with physical changes in the ACC also appear to be correlated with changes in the gyre, but ideas about the apparent relations between fish stocks, the ACC, and the gyre cannot be evaluated from current information gathering. Filling information gaps on the gyre would begin to address the long-term questions of how oceanic productivities and processes in the GOA may contribute to changes in productivity and community structure in watersheds and the marine environment.

3.5.2 Specific Offshore Questions and Information Needs

Five specific offshore (O) questions and related information needs are presented below.

O-1. What is the annual variability in the production of zooplankton in the offshore areas?

Specific Information Needs: Abundance of zooplankton on time and space scales appropriate to understanding annual production.

O-2. How are the supplies of inorganic nitrogen, phosphorus, silicon, and other nutrients essential for plant growth in the euphotic zone annually influenced by climate-driven physical mechanisms in the GOA?

Specific Information Needs: Measurements of inorganic nitrogen, phosphorus, silicon, and other nutrients on time and space scales appropriate to understanding annual variability.

O-3. What is the role of the Pacific High pressure system in determining the timing and duration of the movement of dense slope water onto and across the shelf to renew nutrients in the coastal bottom waters?

Specific Information Needs: Synoptic information on sea level pressure and horizontal and vertical structure of density and nutrients on the outer continental shelf and Alaska Gyre in relation to the ACC on appropriate time and space scales.

O-4. Is freshwater runoff a source of iron and silicon that is important to marine productivity in the offshore and adjacent marine waters?

Specific Information Needs: Levels of biologically available silicon and iron from offshore water in relation to the ACC on appropriate time and space scales.

O-5. Does iron limitation control the species and size distribution of the phytoplankton communities in the offshore areas?

Specific Information Needs: Levels of biologically available iron and species composition and size distribution of the phytoplankton communities from offshore water on appropriate time and space scales.

3.5.3 Offshore Processes

Processes of interest to the GEM program in the offshore habitat are variability in the strength and location of the Alaska Current and Alaskan Stream, gyre activity, and primary and secondary production.

4. PROGRAM COMPONENTS AND STRATEGIES

In This Chapter

- Relationships and functions of tools for implementing the GEM program
- Strategies for program implementation
- The ongoing role of gap analysis

4.1 Program Components

Synthesis,research, monitoring, modeling, and data management and information transfer are the tools to be used in implementing the GEM program. These tools are common to most programs for assessment of living marine resources (Myers et al. 2000). For organizational purposes, retrospective analysis and process studies are treated as forms of research. As a common toolset for monitoring and research, the components are closely related, and their functions sometimes overlap.

4.1.1 Synthesis

The starting point for developing the GEM program is synthesis, because all good science ultimately involves synthesis. In the words of biologist, E. O. Wilson (1998):

> We are drowning in information while starving for wisdom. The world henceforth will be run by synthesizers, people able to put together the right information, think critically about it, and make important choices wisely.

Synthesis builds on and updates current understanding of the northern GOA. It brings together existing data from any number of disciplines, times, and regions to evaluate different aspects of the GEM program central hypothesis, key questions, and related ideas. Synthesis has three broad uses. First, it is used to provide direction for developing hypotheses to be tested and, combined with research and monitoring, to update and refine the conceptual foundation. Second, it is used as a tool–for example, in workshops, meetings, or publications–to inform stakeholders and the public about the developing understanding of the factors responsible for change in the marine environment. And third, synthesis is used to solve resource management problems, by identifying new applications of existing information or by identifying opportunities to solve existing problems through collection of new information. Synthesis is a logical place to begin the cycle of monitoring and research, but once used to initiate a project or component, it logically becomes a companion to research.

For the purposes of the GEM program, synthesis is defined separately from research and from retrospective analysis, a form of research. Synthesis differs from research in the requirement that synthesis be interdisciplinary or concerned with multiple habitat types, or both. Synthesis brings together existing data from any number of disciplines, times, and regions to evaluate the central hypothesis, key questions, specific questions, and related ideas and is usually supported by various forms of retrospective analysis (discussed below). The results of synthesis and research are often used together to solve problems.

4.1.2 Research

Research collects relatively short time series of observations to evaluate some specific aspect of the monitoring program or some testable hypothesis relating to the central hypothesis with fixed limits on project duration. It may build on or use existing data and it may also build models. Testing current understandings through research provides the basis for making changes to the monitoring program and associated components such as modeling, data management, and information transfer.

Retrospective analysis is a specialized form of research that uses existing time series data to evaluate a testable hypothesis or other question of similar specificity relating to monitoring, often supported by statistical modeling. Retrospective analysis contributes to building numerical models and to synthesis.

Research, in the form of *process studies,* plays a vital role in moving beyond the correlative relationships that arise from the monitoring efforts to understand the underlying mechanisms. Process studies develop information on the mechanisms through which energy and matter are transferred across varying scales of time and space. This critical deeper understanding is essential to provide a framework and substance for the numerical modeling and synthesis. Large-scale process studies may encompass ecosystem-level processes occurring across multiple trophic levels, water masses, and habitat types; whereas small-scale studies may deal with mechanisms as specific as the digestion rates of individual animals. Processes such as predation, nutrient transport, and heat transfer are critical to understanding changes in living marine-related resources. Process studies support model building by defining relationships among individuals and species and between phenomena such as primary production and physical forcing. Process studies also contribute to other forms of research, such as retrospective analysis, and to synthesis.

The short-term end point for GEM program synthesis and research is implementation of core monitoring activities. The roles of research and synthesis in the GEM program are first to support implementation of monitoring, and second to give the monitoring program the capacity for change once it is established.

The continuing roles for synthesis and research, as supported by modeling, are to promote understanding of the relationships among and within the broad habitat types of the ecosystems, plant and animal species, physical and chemical oceanographic processes, and climate in the GOA. Continual refinement and testing of hypotheses, synthesis across geographic areas and species, and modeling of biological and physical processes are expected

4.1.3 Monitoring

Monitoring is the action of taking long-time-series observations at times and places designed to test hypotheses based on current understandings. Monitoring is essential to detecting and understanding change, because it provides the starting point for synthesis, various forms of research, modeling, and information transfer. How often and where to sample are important aspects of detection, and therefore, key considerations in the design of monitoring. They must be appropriate to the hypotheses being analyzed.

Monitoring in the GEM program will be organized into core monitoring and partnership monitoring. Core monitoring is fully supported by the GEM program, and partnership monitoring is partially supported.

The end point for monitoring is a geographically distributed network gathering data on the state of the marine ecosystem that is transformed into information for user groups through application of synthesis, research, modeling, data management, and information transfer. Monitoring will use spatially structured survey methods.

4.1.4 Modeling

Models are tools for organizing data and telling a story. Modeling is used to make the relationships between the parts and processes of the ecosystem clear, and models can be written in a variety of media as verbal, visual, statistical, or numerical models. In the GEM program, the specific purposes of modeling are to help accomplish the following:

- Inform, communicate, and provide common problem definition;
- Identify core variables and relationships;
- Set priorities;
- Improve and develop experimental (monitoring) designs; and
- Improve decision-making and risk assessment.

Modeling, monitoring, and data management strategies need to work in concert for each to be fully effective (Figure 4.1). Modeling is a pivotal link between monitoring and data management and information transfer on the one hand, and synthesis and research on the other. Modeling feeds back information to the monitoring program in the form of recommendations on how the monitoring system can be made more effective. Modeling also helps interpret data for the use

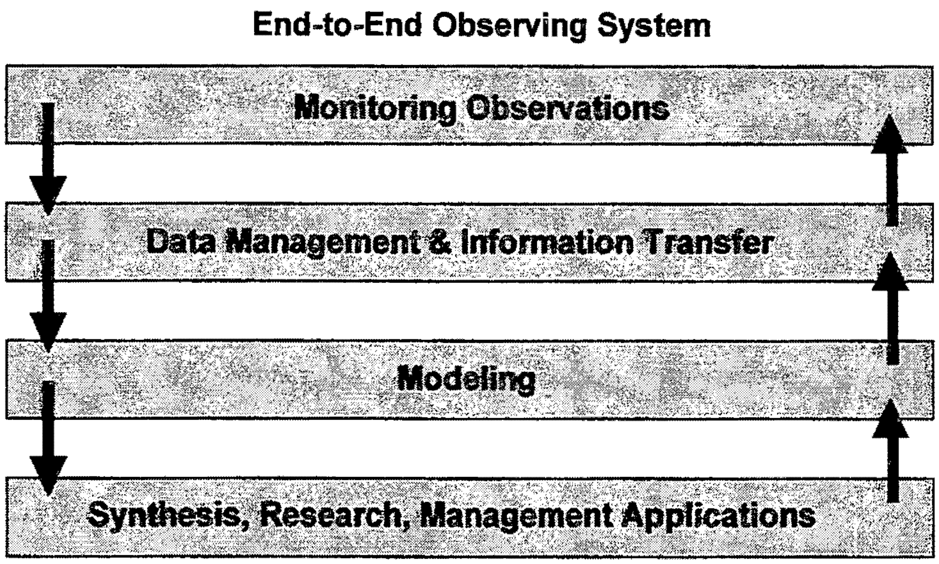

Figure 4.1 The End-to-End Observing System. This system shows the relationships among components of the GEM program (monitoring observations, data management and information transfer, modeling, synthesis and research) and management applications. (Adapted from Tom Malone [U.S. GOOS Steering Committee 2000]).

of synthesis and research activities. Current modeling efforts are considered in more detail in Chapter 5, Volume II. The discussion below provides a brief introduction to definitions and strategies for modeling in the GEM program.

As defined for the purposes of the GEM program, a model may be expressed in verbal, visual, statistical, or numerical languages. Verbal models are also known as "qualitative" and "conceptual"; statistical models are also known as "correlative" and "stochastic"; and numerical models are also known as "deterministic" and "mechanistic." Note that "prediction," "simulation," and "analysis" are not types of models, but uses of models. For example, the use of any kind of statistical or numerical model to reproduce the behavior of a process, such as population growth, is known as a simulation (see Chapter 5, Volume II). The different media for models are explained below.

- Verbal models come in different degrees of precision, from low-precision, narrative explanations of how physical and biological factors combine to produce birds, fish, and mammals (the conceptual foundation, Chapter 4, Volume II), to highly precise statements known as testable hypotheses.
- Visual models, such as **Figure 4.2 (need figure)** of the conceptual foundation, are graphic images of verbal models.
- Statistical models and related mathematical techniques promote understanding of whether verbal models are worth considering further. By comparing combinations of measurements, such as fish growth rates at

different water temperatures, statistical methods show the likelihood of relationships among phenomena, but not how or why they are related.

- Numerical models are mathematical translations of verbal models describing how and why phenomena are related. Numerical models often rely on established principles from physics, chemistry, and biology.

All four types of models will be used in the GEM program. In the near-term, however, models of biological phenomena are expected to be mostly verbal, visual, and statistical, whereas models of physical and chemical phenomena are likely to be primarily numerical, in addition to being verbal and statistical.

Models are tools not only for understanding, but also for predicting change. Models organize and analyze monitoring observations of plants and animals, natural forces, and human activities. With the use of the mathematics of modeling, short-term predictions can be made about how a particular aspect of the ecosystem works. The ultimate demonstration of understanding a phenomenon, however, is longer-term prediction. Covering the vast distance between current understanding of the productivity of living marine-related resources and predicting changes on longer time scales (weeks, months, and years) will require thousands of small steps in understanding. This progression will necessarily take a long time. Because of the time required, identifying the relationship between current understanding and probable changes in resource productivity is a reasonable goal for a long-term program such as the GEM program.

The long-term modeling end points for GEM monitoring, synthesis, and research are working biophysical models that make managers, policy makers, and resource users aware of changes in natural resources, help them understand the human and natural origins of these changes, and give them some idea of what to expect in the future.

4.1.5 Data Management and Information Transfer

Data management and information transfer are the processes of acquiring in the field, receiving in the office, formatting, and storing data; providing quality control and assurance; developing and managing databases; and making the data understandable to users. It includes the development of information products based on interpreted data and the delivery of these products, including development of user interfaces. The short-term objective of data management and information transfer in the GEM program is to gain control of the data acquired with EVOS funds. Many of these data are in danger of being lost as the passage of time leads to loss of project personnel and institutional memory.

The long-term end point for GEM data management and information transfer is a system that manages the rapid and efficient flow of data and information based on core monitoring projects to end users, and that facilitates the flow of data and information between GEM partners and among GEM partners and the user community.

GEM data management is a program support function intended to accomplish the following:

1. Support cross-disciplinary integration of physical, biological, and traditional knowledge within a structured, decision-making framework;
2. Support synthesis, research, and modeling that evaluate testable hypotheses on the roles of natural forces and human activities in controlling biological production; and
3. Lay the groundwork for future use of distributed, Web-based analysis and management tools as the monitoring program becomes fully operational.

By necessity, the data incorporated into the GEM program will derive from a variety of sources and formats, which will include retrospective data sets and traditional knowledge, may contain spatial and temporal components.. Synthesis and research will need to incorporate data not directly collected by the GEM program, such as satellite remote-sensing information and fishery catch data. Incorporation of these data into regional models and decision-making systems will require tools for data ingestion and query, especially to facilitate modeling (see Figure 4.1). Because the output from the GEM program will be used by people from a wide variety of disciplines and backgrounds, the user interface must be easy to understand and accessible through a distributed network, such as the Internet.

Data management and acquisition policies are essential to ensure the rapid transfer of information to end users. Although the data must flow through the system as quickly as possible, quality control and assurance procedures and the prerogatives of scientists to publish interpretations of the data need to be respected. One approach that may prove useful is the establishment of "peer reviewed" data sets that allow the scientists involved to receive credit for their efforts in the publications of other scientists who may use the data.

Information transfer products will depend on the nature of the monitoring and research activities (see Chapter 5) that are yet to be chosen. Possibilities for these products, based on the experience of other monitoring and research programs, are discussed in Chapter 6, Volume II.

4.2 Strategies for Implementation

The scientific strategy of the GEM program uses a central hypothesis and key questions from the conceptual foundation to establish the initial direction for the program. From this starting point, the GEM program follows a path of synthesis, research, and monitoring to detect, understand, and, eventually, predict changes in living marine-related resources of the GEM region. As shown in the table below, the strategy calls for modeling and data management to closely support synthesis and research.

The way to achieve prediction in the long term is to build a body of knowledge on how and why the productivity of living marine-related resources changes through time. Synthesis is used to build and maintain a coherent and comprehensive understanding of the current state of knowledge. Research tests current understandings. Monitoring activities take long-time-series observations at times and places designed to test hypotheses based on current understandings. And at all stages of the program, an ongoing gap analysis demonstrates when it is possible to take advantage of the work of others **(Figure 4.3) (need figure).**

The basic sequence of activities for establishing the monitoring network is envisioned as follows:

Synthesis → Research → Monitoring

Concurrent programs of modeling and data management would support the sequence of synthesis, research, and monitoring. Table 4.1 illustrates this implementation strategy.

Table 4.1 Strategy for Implementing a Monitoring Network

Example of building a monitoring activity for the GEM program in 5 fiscal years through synthesis and research, supported by concurrent modeling and data management.

	Monitoring Activity			
Fiscal Year	**Core**	**Partners**	**Model**	**Data Management**
2003	Synthesis Research	Monitor	Verbal(c)	Prototype
2004	Synthesis Research	Monitor Research	Statistical(c)	Coordination (c) Archiving(c)
2005	Research	Monitor Research	Statistical(c) Numerical prototype (p)	Coordination (c) Archiving (c) Distribution (p)
2006	Research Monitor	Monitor Research	Statistical(c) Numerical (p)	Coordination (c) Archiving (c) Distribution (p)
2007	Monitor Research	Monitor	 Numerical (p)	Archiving (c) Distribution (p)

Notes:

c = core (GEM program supported) activity

p = partnership (jointly supported) activity

The implementation strategy shown in Table 4.1 uses the basic components of the program in a series of three steps that lead gradually to the identification and establishment of a long-term monitoring program. The first step is increased synthesis of existing information, continuing the process started in preparing the scientific background (Chapter 3, Volume II) and in conjunction with exploratory research projects that build on current synthesis. The GEM program is now at this step, with ongoing synthesis and preliminary research expected to continue through Fiscal Year (FY) 2002. The initial synthesis activities, including modeling, would support identification and development of testable hypotheses. Initial research activities would explore the feasibility of measuring candidate variables at various localities in the watershed, nearshore, and offshore. Initial synthesis in the nearshore and offshore areas would rely heavily on past and developing information from research and monitoring programs such as SEA, FOCI, OCC, and GLOBEC (see Appendix C), and on past and ongoing monitoring and research in the watersheds under ADF&G, USFWS, U.S. Forest Service (USFS), and others.

The second step, to be initiated in FY 03, combines continuing synthesis with research that examines opportunities for core monitoring in PWS, the outer Kenai Peninsula, Lower Cook Inlet, Kodiak, and adjacent waters. All research projects are initiated for a fixed duration; however, some of these initial projects might be considered "pilot monitoring" projects that could be extended indefinitely if results of retrospective analyses, workshops, modeling studies, synthesis, and other preparatory research show continuation is warranted.

The third step is full implementation of a long-term monitoring program. As identified by the preparatory synthesis, research, and modeling, each core monitoring activity would collect data on a number of core variables that support evaluation of testable hypotheses. Partners may fund additional measurements at the location of core monitoring activities. For example, with proper planning it is usually possible to add monitoring equipment to moorings without disrupting existing activities for data acquisition. It may also be advantageous for partners to incorporate core monitoring locations into their own transects and other surveys. The actual number of core monitoring activities at full implementation at the end of FY 07 will depend on how much funding is available and the needs demonstrated by the results of retrospective analyses, workshops, modeling studies, synthesis, and other preparatory research.

4.3 Gap Analysis: An Ongoing Strategy for Implementation

The identification of information needs, or gap analysis, is an important part of the process of identifying the starting points for monitoring and research (Chapter 5, Volume I). It will continue to be an important part of implementation. In the process of starting the GEM program, the available information (Appendix C) was compared to the information relevant to answering the key questions (Chapter 4, Volume II) to see what information was missing (Chapter 3, Volume I). This process will continue during implementation; however, the more general key questions will be replaced by increasingly specific questions.

It is important to have a clear understanding of how the nature of the question determines the nature and outcome of the gap analysis. The gap analysis has three essential parts:

1. A question;
2. Identification of information necessary to answer the question; and
3. A survey of relevant available information.

The first part, the question, is fundamental to the gap analysis and defines the survey of all relevant information needed to answer it. A general question calls for a general gap analysis, and a more detailed question calls for a more detailed gap analysis. The gap analysis concludes with a comparison of the information needed and the information available.

As the GEM program moves from general questions about what controls biological production within habitats and the connections among production in these habitats toward testable hypotheses, the gap analysis will become highly specific. Testable hypotheses will be developed during the second half of FY 02. More detailed gap analysis will be done when the process reaches the level of testable hypotheses, with highly specific questions, in FY 03.

A continuing gap analysis, supported by a continuously updated database of current and historical information-gathering projects in the GOA and adjacent areas, is essential to implementing the GEM program. This analysis will be key to finding new partners for monitoring activities, identifying new opportunities for research and synthesis, and providing increased opportunities for collaboration, without risking duplication.

The immediate end point of the gap analysis strategy is a database that supports identifying information needs in the short term, as core monitoring variables and locations are selected. In the longer term, the supporting database will become a valuable tool for resource managers, policy makers, other scientists, stakeholders, and the general public.

4.4 References

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5. MONITORING PLAN AND RESEARCH AGENDA

In This Chapter

- Elements of the phased approach to monitoring
- Use of synthesis, research, modeling, and data management to develop and refine monitoring activities
- Fiscal Year 2002 agenda for activities

5.1 Introduction

The monitoring program developed by the Trustee Council and its partners is intended to be the "flagship" of the GEM program. The monitoring program is the heart of the GEM program and will be maintained even if funding levels vary. Synthesis, research, modeling, and data management will all be used to develop and refine monitoring activities. A phased approach is envisioned during a 5-year period, from FY 03 to FY 07, and will incorporate these elements:

- Use of the *key question* for each habitat as the starting point for performing the necessary synthesis and research for developing testable hypotheses.
- A table showing a *proposed schedule and strategy for implementation*, FY 03 to FY 07, for core and partnership activities, models, and data management.
- Lists of probable or *prospective partners* that are actively doing related monitoring or research in the broad habitat type.
- *Candidate (or possible) core monitoring activities* recommended based on the conjunction of partnership opportunities and opportunities for measuring biological and physical quantities related to the key question and information gaps.
- *Candidate (or possible) core variables* recommended based on approaches suggested by the literature reviewed in the scientific background (Chapter 3, Volume II).

Following a discussion of data management, this chapter discusses the above monitoring program elements for each habitat type. The key questions were introduced in Chapter 3, Volume I.

5.2 Data Management

Because data management functions and products are generic to all habitat types, the suggested implementation strategy provided in this section is applicable for all four habitat types. Core data management will be prototyped in FY 03 as core synthesis and research projects are initiated and partnerships formed. The first core function is to establish coordination among parties as soon as possible, but no later than FY 04, by means such as file transfer protocol (ftp) sites, Web sites, and e-mail forwarding lists. As data from core and partnership research projects are produced, around FY 04, archiving of data will be essential to serve research needs. A partnership system of data distribution will be designed to make information products readily available to partners and other user groups. The ultimate goal for all broad habitat types will be an end-to-end system, in which a monitoring network provides data to models and other applications that provide services to a variety of end users, including the ongoing GEM synthesis, research, and modeling itself.

5.3 Watersheds

5.3.1 Key Question

What are the relative roles of natural forces, such as climate, and human activities, such as habitat degradation and fishing, as distant and local factors, in causing short-term and long-lasting changes in marine-related biological production in watersheds?

5.3.2 Schedule

Development of watershed monitoring activity will be led by a core synthesis effort in FY 03, building on preparatory core research in FY 02 to establish an approach to measuring levels of marine influence in animals and plants of the watersheds. Core synthesis will assist in developing hypotheses by about FY 04 that can be tested and refined by core research in FY 05 and FY 06. At least one core monitoring station will be initiated by FY 06, but may not be fully operational until FY 07.

Table 5.1 presents the proposed schedule and strategy for implementation.

5.3.3 Prospective Partner Activities

Partner activities in FY 03 are expected to be the supporting monitoring programs already in place, such as enumeration of animals and plants; water quality monitoring; existing hydrology models, including annual and seasonal runoff; and permitting of human impacts such as resource harvests and land development. Starting in FY 04, partners will be encouraged to assist in funding research to further site selection. This activity will extend through FY 06, terminating after the monitoring station is fully operational. Because an analogous research program is under way at Washington Department of Fish and Wildlife (WDFW), that agency may be willing to share information and the costs of process studies of mutual interest.

Table 5.1 Proposed Implementation Strategy for Watershed Habitat

Fiscal Year	Monitoring Activity		Model	Data Management
	Core	Partners		
2003	Synthesis Research	Monitor	Verbal(c)	Prototype
2004	Synthesis Research	Monitor Research	Statistical(c)	Coordination (c) Archiving(c)
2005	Research	Monitor Research	Statistical(c) Numerical prototype (p)	Coordination (c) Archiving (c) Distribution (p)
2006	Research Monitor	Monitor Research	Statistical(c) Numerical (p)	Coordination (c) Archiving (c) Distribution (p)
2007	Monitor Research	Monitor	 Numerical (p)	Archiving (c) Distribution (p)

Notes:

c = core (GEM program supported) activity

p = partnership (jointly supported) activity

Prospective partners: ADF&G, USFWS (Kenai Natural Wildlife Refuge [KNWR]), USGS, EPA, ADEC, USFS, Cook Inlet Keeper (CIK), Alaska Department of Natural Resources (ADNR), and Washington Department of Fish and Wildlife (WDFW)

Candidate core monitoring activities: Kenai River watershed, Karluk River watershed

Candidate core variables: isotopes of nitrogen in aquatic and riparian plants and animals, precursors of reduced iron in water, and anadromous fish

5.3.4 Models

Models of the relationship between marine productivity and watershed productivity (Finney et al. 2000) are supposed to be verbal as of FY 03. Statistical modeling to describe the strength of relations among variables and power analysis to guide sampling should start in FY 04, continuing through the evaluation of the initial monitoring station in FY 06. The end point of modeling will be a numerical model of the geochemistry of the core variable(s) in the watershed to the boundary of the interidal-subtidal areas. This model will be initiated in about FY 05 and operational (in some sense) by FY 07. It is recognized that a number of partner monitoring activities in addition to the core activity will be needed to create parameters for a numerical model. If numerical modeling proves intractable, statistical modeling would be extended in the interim.

5.3.5 Candidate Core Monitoring Activities

Candidate core monitoring activities will be chosen to build on existing long time series of data collected by prospective partners. The Kenai and Karluk rivers are two likely candidates. For the Kenai River watershed, three decades of data on adult salmon returns to the spawning grounds of the watershed can be used as estimates of marine influence. In addition, salmon catch data span more than five decades. The proximity to Anchorage places the Kenai River watershed under heavy pressure from human activities and impacts, many of which are documented by government regulators. Multiple prospective partners have extensive programs in place to monitor vegetation, terrestrial animals, limnology, and other variables of potential relevance to the key question. The Karluk River watershed is unique in having a published record of more than 300 years of changes in marine influence in general, and marine nitrogen in particular (Finney et al. 2000). In addition, the prospective partners have collected more than eight decades of counts of salmon returns for the watershed.

5.3.6 Candidate Core Variables

Isotopes of nitrogen in plants and animals and sources of reduced iron are candidates for core variables, based on work described in the scientific background under marine-terrestrial connections (Section 5.3) and chemical oceanography (Section 5.5). In watersheds of the GEM region, where nitrogen limits productivity, marine nitrogen in anadromous fish species, principally salmon, could be an important driver of watershed productivity. Phosphorus and iron from salmon may also be important to watershed productivity, but direct measures of the origin of these elements are not available. (Indirect measures might be; for example, phosphorus or iron concentration per gram of fish times average fish weight times return number.) A decade of work on the role of iron in primary productivity in marine areas suggests that geophysical and biological processes in watersheds may contribute to marine productivity. Processes in the watersheds may limit marine productivity by controlling the availability of precursors of reduced iron.

5.4 Intertidal and Subtidal

5.4.1 Key Question

What are the relative roles of natural forces, such as currents and predation, and human activities, such as sediment and pollutant discharge, as distant and local factors, in causing short-term and long lasting changes in community structure and dynamics of the intertidal and subtidal habitats?

5.4.2 Schedule

Development of the intertidal and subtidal monitoring activities is expected to begin with a planning workshop in FY 02 and an intense core synthesis effort in FY 03 that involves extensive preparatory core research. The inherently high variability of the community structure of the intertidal and subtidal habitat–and its vulnerability to the effects of predation and human degradation–may make it difficult to develop a design that can separate human activities from natural forces, forestalling implementation of initial monitoring until FY 06.. Core synthesis is planned to provide hypotheses by about FY 05 that can be tested and refined by core research in FY 06 and FY 07. Plans call for at least one core monitoring station to be initiated by FY 06, but it may not be fully operational until FY 07.

Table 5.2 presents the proposed schedule and strategy for implementation.

Table 5.2 Proposed Implementation Strategy for Intertidal and Subtidal Habitat

	Monitoring Activity			
Fiscal Year	**Core**	**Partners**	**Model**	**Data Management**
2003	Synthesis Research	Monitor	Verbal(c) Statistical(c)	Prototype Coordination (c)
2004	Synthesis Research	Monitor Research	Verbal(c) Statistical(c)	Coordination (c) Archiving(c)
2005	Research	Monitor Research	Verbal(c) Statistical(c)	Coordination (c) Archiving (c) Distribution (p)
2006	Research Monitor	Monitor Research	Statistical(c)	Coordination (c) Archiving (c) Distribution (p)
2007	Monitor Research	Monitor	Statistical(c) Numerical prototype (p)	Archiving (c) Distribution (p)

Notes:

c = core (GEM program supported) activity

p = partnership (jointly supported) activity

Prospective partners: ADF&G (Kachemak Bay National Estuarine Research Reserve [KBNERR]), NOAA (National Ocean Service and UAF), Cook Inlet Regional Citizens Advisory Council (CIRCAC), Prince William Sound Regional Citizens Advisory Council (PWSRCAC), USFS, EPA-ADEC EMAP), Alyeska Pipeline Service Company

Candidate core monitoring activities: Kachemak Bay (Lower Cook Inlet), Green Island (PWS)

Candidate core variables: substrate type and distribution, species composition and distribution, recruitment

5.4.3 Prospective Partner Activities

Partner activities in FY 03 will be the supporting monitoring programs already in place, such as monitoring of individual species for basic biology and contaminant loads, surveys of species composition and distribution, surveys of substrates, and measurements of physical oceanography (see Table 5.2). Starting in FY 04, partners will be encouraged to assist in funding research to further site selection. These activities will extend through FY 06, terminating after the monitoring station is fully operational in FY 07.

5.4.4 Models

Models of changes in community structure of the intertidal-subtidal areas in response to human activities and natural forcing are expected to be primarily verbal from FY 03 to FY 05. Statistical modeling, particularly power analysis to guide sampling, is expected to be operable as soon as FY 03, because of experience gained in the EVOS coastal habitat program and related damage assessment and restoration work. Statistical modeling will continue through the evaluation of the initial monitoring station in FY 06. The end point of a numerical model to combine physical forcing and human activities for describing community structure is a very ambitious undertaking for a core activity within a 5-year time frame and may not be feasible at all without substantial partner support.

5.4.5 Candidate Core Monitoring Activities

Candidates for core monitoring activities will be selected based on substantial partnering opportunities, chances for human activities and impacts, and logistics. Likely candidates are Kachemak Bay in Lower Cook Inlet and Green Island in PWS. Kachemak Bay is close to the city of Homer and is becoming a developed recreational destination. In addition, the bay has the presence of coastal habitat assessment programs already in place within the Kachemak Bay National Estuarine Research Reserve (KBNERR), as well as nearby moorings taking oceanographic measurements. The USFS has a long-term ecological monitoring site at Green Island, which is still seeing effects from the 1989 oil spill. A new weather station is being installed nearby at Applegate Rocks, and additional oceanographic moorings in nearby Montague Strait are likely.

5.4.6 Candidate Core Variables

Community structure in the intertidal and subtidal areas is determined by substrate type and amount, as well as by physical oceanographic features, such as wave action. Species composition and distribution are fundamental to determining community structure, as is the recruitment rate of key species such as barnacles, mussels, and clams, depending on substrate.

5.5 Alaska Coastal Current

5.5.1 Key Question

What are the relative roles of natural forces, such as the variability in the strength, structure, and dynamics of the ACC, and human activities, such as fishing and pollution, in causing local and distant changes in production of phytoplankton, zooplankton, birds, fish, and mammals?

5.5.2 Schedule

Development of ACC monitoring will require a period of synthesis and research that involves collaboration between physical and biological scientists to decide on how to best detect changes in annual and seasonal production and transfer of energy to higher trophic levels. The determination of what physical-chemical processes are most important to measure for primary and secondary production will require a synthesis that combines existing physical and biological information and hypotheses. Specific seasonal questions such as what controls the timing, duration, and magnitude of the spring bloom on the inner continental shelf need to be carefully cast as testable hypotheses before committing to long-term monitoring. Having the SEA, APEX, GLOBEC Northeast Pacific National Estuary Program (NEP), FOCI, OCC, and NPAFC programs precede and parallel the GEM program is extremely fortuitous for development of this component. The experience and lessons from these programs will be extremely beneficial in helping GEM build its core monitoring components. For these reasons, development of ACC monitoring activity will begin with a core synthesis effort that is closely coordinated with the ongoing research and monitoring efforts mentioned above.

Understanding how best to measure biological productivity and trophic transfer in the ACC will take longer to develop than the approach to physical measurements, which could be developed in a relatively short period of time. The long-term observation program being carried out in PWS and across the shelf in the northern GOA under GLOBEC started in 1997 and will extend through 2004. Intense process studies are scheduled for 2001 and 2003. It will take some time to distill the large amount of information available from such studies and other programs to the point of recommending a full suite of core biological measurements for core GEM program monitoring in the ACC.

Table 5.3 presents the proposed schedule and strategy for implementation.

5.5.3 Prospective Partner Activities

NOAA's interest in the ACC continues to be high, as demonstrated through its participation in the GLOBEC and OCC programs and some continuing work in the FOCI program in Shelikof Strait. It is almost certain that the GAK1 station and line, maintained and monitored by the University of Alaska and in place now for decades, will play a central role in future monitoring of the physical structure of the ACC based on temperature and salinity measures. Recently added biological measures, including chlorophyll a, will likely be maintained and supplemented. Other opportunities for partnerships include GLOBEC's more recently established stations from PWS across the continental shelf and one of the lines used in the FOCI program in the Shelikof Strait. The USGS, which has an established set of seabird monitoring colonies spaced at about 500-km intervals around the GOA and into the Bering Sea, is another strong candidate for a partner. Close coordination with methods of the colonial seabird program of the USFWS Alaska Maritime Refuge is envisioned to make seabird data consistent around the coast of Alaska. For measuring forage species variability, population abundance data from the ADF&G on Pacific herring in PWS and also for populations at Kodiak Island and in Kamishak Bay, although not complete, may be useful. Starting in FY 04 and extending through FY 06, partners will be encouraged to assist in funding research to further site selection for monitoring the ACC.

Table 5.3 Proposed Implementation Strategy for Alaska Coastal Current Habitat

	Monitoring Activity			Data
Fiscal Year	**Core**	**Partners**	**Model**	**Management**
2003	Synthesis Research	Monitor	Statistical(c) Numerical (p)	Coordination (c)
2004	Synthesis Research	Monitor Research	Statistical(c) Numerical (p)	Coordination (c) Archiving(c)
2005	Research	Monitor Research	Statistical(c) Numerical prototype (p)	Coordination (c) Archiving (c) Distribution (p)
2006	Research Monitor	Monitor Research	Statistical(c) Numerical (p)	Coordination (c) Archiving (c) Distribution (p)
2007	Monitor Research	Monitor	 Numerical (p)	Archiving (c) Distribution (p)

Notes:

c = core (GEM program supported) activity

p = partnership (jointly supported) activity

Prospective partners: UAF (IMS, School of Fisheries and Ocean Sciences [SFOS]), U.S. Department of Interior (DOI) (National Park Service [NPS], USFWS, USGS), North Pacific Research Board (NPRB), NOAA (NMFS/National Ocean Service [NOS]), EPA-ADEC EMAP

Candidate core monitoring activities: GAK1, Hinchinbrook Entrance, Montague Strait

Candidate core variables: temperature, salinity, fluorescence, plankton, forage species

Plankton measurements (settled volume) are now being taken by potential partners at six hatcheries in PWS. On the basis of past correlations of plankton-settled volume with annual pink salmon returns and decadal-scale herring abundance, these data could provide information about productivity of the ACC system of relevance to multiple species under certain conditions. Extension of the "plankton watch" to hatcheries in other areas and local communities throughout the northern GOA may be a worthwhile and potentially economical way to maintain long-term data sets and archives of plankton. Other opportunities to collect samples and analyze plankton communities may include cruises with net and hydroacoustic sampling, as well as satellite images. Also of possible merit are the use of ships that offer opportunities; for example, the continuous plankton recorder is recommended to be deployed on oil tankers traveling from Valdez to Long Beach under EVOS sponsorship in FY 02. Certainly any satellite images of the sea surface that measure chlorophyll a concentrations provide very useful synoptic pictures, even taking into account the limitations that cloud cover and lack of subsurface data present. Decisions will be made with the guiding philosophy of collecting data of relatively low frequency in space and time so that decadal scale change can be resolved.

Perhaps the largest challenge for the ACC habitat will be developing monitoring activities to measure variability in forage fish populations and associated predator populations. Some options for exploration of partnerships for assessing forage fish abundance and associated phenomena include the following:

- Larval surveys building on the databases and archived specimens from the FOCI program.
- Use of forage fish occurrence in the stomachs of large fish collected in the sport fishery–or in some of the large fishery assessment programs conducted by NOAA and ADF&G–as an index of relative abundance. (The Trustee Council sponsored a successful study of these occurrences of forage fish in the sport fishery for halibut out of Homer.)
- Small mesh trawl surveys conducted by ADF&G around Kodiak Island and Lower Cook Inlet to assess shrimp abundance. (A large database from this program extends for some locations back to the 1960s for a large variety of species on the inner shelf.)
- Aerial surveys with the use of conventional photography or other sorts of imaging (such as LIDAR) of shallow water aggregations of juveniles or adults.
- Hydroacoustic sensors mounted on various ships of opportunity and fixed moorings.
- Analysis of food items brought back to the nests of colonial seabirds (such as puffins) as an indication of the relative abundance of various forage fish species in particular areas.
- Other net sampling programs that may be under way or contemplated.

5.5.4 Models

Several hydrographic and circulation models have been or are being developed for the ACC (see also Chapter 5, Volume II, and Appendix B). A circulation model workshop is planned in FY 02 to consider approaches most likely to be useful to the GEM program. Models of the relationship of marine planktonic production to water column structure have been developed in the EVOS SEA program (Eslinger et al. 2001) and are expected to eventually be further developed under the GEM program.

The GLOBEC nutrient-phytoplankton-zooplankton (NPZ) 1-D and 3-D models are a suite of coupled biological-physical models concerned with the coastal region of the GOA. They are addressing effects of concern to the GEM program in the ACC and offshore: cross-shelf transport, upstream effects, local production, and conditions conducive to suitable juvenile salmon rearing habitat.

Models of particular interest from the FOCI program are the 1-D and 3-D versions of the Shelikof NPZ models, and the GOA Walleye Pollock Stochastic Switch Model (SSM) (see Chapter 5, Volume II, and Appendix B). The Shelikof NPZ models are a set of coupled (biological and physical) models designed to examine hypotheses about pollock recruitment in the Shelikof Strait region. The Pollock SSM is a numerical simulation of the process of pollock recruitment. Of particular interest to the GEM program is the identification by the SSM of three specific agents of mortality: wind mixing, ocean eddies, and random effects. Ecopath models developed by Okey, Pauly, and others at the University of British Columbia are also of interest, especially for PWS, but also for the GOA continental shelf and slope (excluding fjord, estuarine, and intertidal areas) (see Appendix B).

5.5.5 Candidate Core Monitoring Activities

It appears that the physical oceanographers have developed a level of understanding about inner-shelf dynamics that will allow the GEM program to identify a core set of measurements, locations, and frequencies that address questions relevant to the GEM program. A core monitoring activity based on the partnership at the GAK1 station is likely. Others may be added in FY 04 to FY 07 as identified by synthesis and the results of other programs (GLOBEC and FOCI stations and moorings) and as funding allows. Full core monitoring in the ACC may not be fully operational until FY 07.

5.5.6 Candidate Core Variables

The key variables in measuring the productivity of the ACC are temperature, insolation, salinity, fluorescence, and abundance of key forage species, including fish and zooplankton.

5.6 Offshore: Outer Continental Shelf and Oceanic Waters

5.6.1 Key Question

What are the relative roles of natural forces, such as changes in the strength of the Alaska Current and Alaskan Stream, mixed layer depth of the gyre, wind stress, and downwelling, and human activities, such as pollution, in determining production of carbon and its shoreward transport?

5.6.2 Schedule

As with the ACC portion of the program, results of GLOBEC research need to be carefully considered before implementation of long-term monitoring in this broad habitat type. This deliberate approach is reflected in the emphasis on synthesis for this habitat type in the early years of the proposed schedule and strategy for implementation (Table 5.4).

Table 5.4 Proposed Implementation Strategy for Offshore Habitat

Fiscal Year	Monitoring Activity		Model	Data Management
	Core	Partners		
2003	Synthesis	Monitor Research	Statistical(c)	Coordination (p)
2004	Synthesis	Monitor Research	Statistical(c)	Coordination (p) Archiving(p)
2005	Synthesis	Monitor Research	Statistical(c) Numerical prototype (p)	Coordination (p) Archiving (p) Distribution (p)
2006	Synthesis	Monitor?	Statistical(c) Numerical (p)	Coordination (p) Archiving (p) Distribution (p)
2007	Synthesis	Monitor?	Numerical (p)	Archiving (p) Distribution (p)

Notes:

c = core (GEM program supported) activity

p = partnership (jointly supported) activity

Prospective partners: NPRB, NOAA (NMFS/NOS), Canadian Department of Fisheries and Oceans (CDFO), Japan Fishery Agency.

Candidate core monitoring activities: GLOBEC stations, Valdez-Long Beach Line

Candidate core variables: nutrients, detritus and plankton, temperature, and salinity.

5.6.3 Prospective Partner Activities

Support of partners in existing monitoring projects may be necessary to obtain sufficient information for design of a monitoring program. Because of the expense of initiating most offshore sampling programs, careful selection of partners and the use of long-term, low-frequency data gathering will be key strategies for understanding decadal-scale changes in this environment. Current efforts to apply the continuous plankton recorder (CPR) technology on ships of opportunity in the GOA offer partnership opportunities. Extension of existing ships of opportunity programs to include measurement of variables of interest to the GEM program is also a possibility.

5.6.4 Models

The GLOBEC NPZ 1-D and 3-D models are discussed above in Section 5.5.4. A broader model addressing NPZ for the entire North Pacific is the North Pacific Ecosystem Model for Understanding Regional Oceanography (NEMURO), in which fluxes of nitrogen, silicon, and carbon will be tracked (see Appendix B).

5.6.5 Candidate Core Monitoring Activities

A reasonable oceanographic program in the ACC can probably be extended across the shelf break with the use of existing GLOBEC, FOCI, and OCC sampling stations, moorings, and transects. The use of the Valdez-Long Beach line with oil tanker-mounted fluorescence and zooplankton sampling gear appears to be an attractive strategy for long-term, low frequency sampling over large spatial scales.

5.6.6 Candidate Core Variables

Particularly crucial aspects of the offshore environment are physical processes and attendant biological responses at the shelf break and front (for example, extent of deep-water intrusion onto the shelf in the late summer and fall); the mixed layer depth in the Alaska Gyre in the spring-summer; and Ekman transport of offshore production onshore. Measurements of basic variables are essential to understanding the role of these offshore aspects in affecting productivity of other habitats. These variables include temperature, salinity, nutrients, detritus, and plankton.

5.7 Research Agenda in Support of Monitoring

The "research agenda" is a list of past and potential Trustee Council activities that future committees and work groups within each habitat type (Chapter 6, Volume I) can build upon. Table 5.5 summarizes the planned and potential activities of FY 02 that are of interest in establishing the research agenda for GEM implementation. Tables 5.6 and 5.7 summarize activities funded by the Council in FY 01 and FY 00 that are of potential interest to GEM implementation.

Editorial note: We definitely want to include Tables for FY 00 and FY 01 for studies that were done for "GEM transition and synthesis"

Table 5.5 Fiscal Year 2002 Funded and Deferred Activities for the GEM Program
Listed with project number if assigned and titles of activities.

Habitat Type	Synthesis and Workshops	Research	Modeling
Watersheds	02612–Kenai River Marine-Terrestrial Links	02649–Reconstructing sockeye 02667–Commission for the Conservation of Antarctic Marine Living Resources Ecosystem Monitoring Program (CEMP) 02668–Water Quality Database	
Intertidal-Subtidal	02395–Workshop on intertidal monitoring	02556–Mapping intertidal 02538–Herring stock identification 02210–Youth Area Watch	
ACC	Workshop on modeling circulation	02340–GAK1 02552 Exchange between PWS and GOA[a] 02614–Physical data from tankers 02671–Ships opportunity in Lower Cook Inlet 02584–Airborne remote sensing 02561–Community based forage fish sampling 02404–Archival tag testing 02538–Herring stock identification 02210–Youth Area Watch	02603–Ocean Circulation Modeling[a]
Offshore	Workshop on modeling circulation	02614–Physical data from tankers 02624–Ships opportunity CPR (Continuous Plankton Recorder)	02603–Ocean Circulation Modeling[a]

[a]Funding decision deferred to 12/01

Table 5.6 Fiscal Year 2001 Funded Activities for the GEM Program
Listed with project number if assigned and titles of activities.

Habitat Type	Synthesis and Workshops	Research	Modeling
Watershed			01391–Cook Inlet Information System 0145–Data System for GEM
Intertidal-Subtidal		01385–Kachemak Bay Monitoring 01210–Youth Area Watch	01391–Cook Inlet Information System 01455–Data System for GEM
ACC		01340–GAK1 01552–Exchange between PWS and GOA 01404–Archival tag testing 01210–Youth Area Watch	01389–3-D Ocean State Simulation Modeling 01391–Cook Inlet Information System 01455–Data System for GEM
Offshore			01389–3-D Ocean State Simulation Modeling 01391–Cook Inlet Information System 01455–Data System for GEM

Table 5.7 Fiscal Year 2000 Funded Activities for the GEM Program
Listed with project number if assigned and titles of activities.

Habitat Type	Synthesis and Workshops	Research	Modeling
Watersheds		00567 Contaminants monitoring	01391 Cook Inlet Information System 00455 Data System for GEM
Intertidal-Subtidal	00374 Herring recommendations	00210–Youth Area Watch 00501 Seabird monitoring protocols 00509 Harbor seal experimental design 00510 Intertidal monitoring recommendations 00567 Contaminants monitoring	01391 Cook Inlet Information System 00455 Data System for GEM
ACC	00374 Herring recommendations	01340–GAK1 00552 Exchange between PWS and GOA 00210–Youth Area Watch 00493 Sampling strategies for GOA trawl survey 00501 Seabird monitoring protocols 00567 Contaminants monitoring	01391 Cook Inlet Information System 00455 Data System for GEM
Offshore		00567 Contaminants monitoring	01391 Cook Inlet Information System 00455 Data System for GEM

5.8 References

Eslinger, D., Cooney, R. T., McRoy, C. P., Ward, A., Kline, T., Simpson, E. P., Wang, J., and Allen, J. R. 2001. Plankton dynamics: observed and modeled responses to physical factors in Prince William Sound, Alaska. Fisheries Oceanography in press

Finney, B. P., Gregory-Eaves, I., Sweetman, J., Douglas, M. S. V., and Smol, J. P. 2000. Impacts of climatic change and fishing on Pacific salmon abundance over the past 300 years. Science 290: 795-799.

6. PROGRAM MANAGEMENT: PUBLIC ADVICE, SCIENTIFIC GUIDANCE, AND DATA POLICIES

In This Chapter

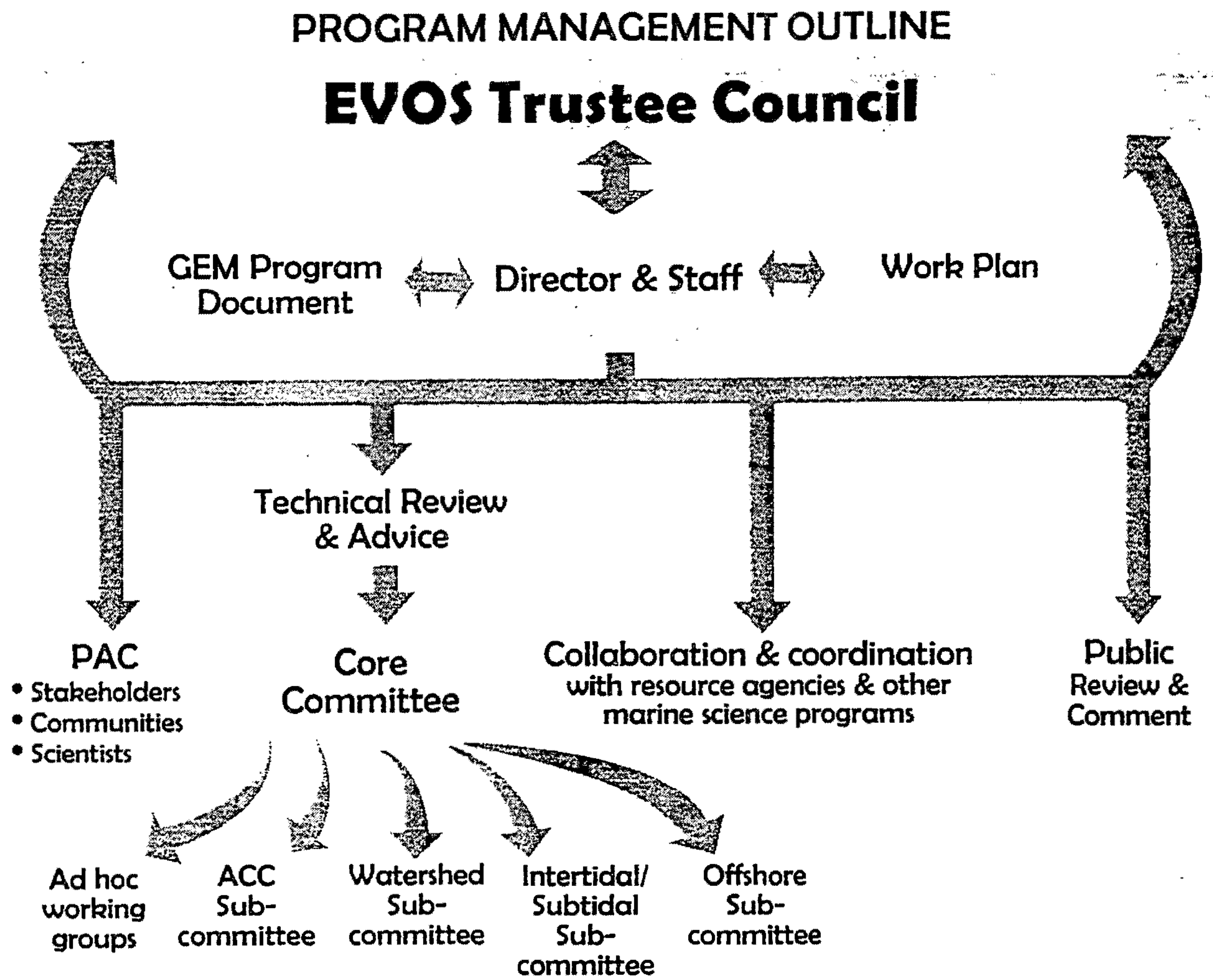
- Discussion of a reconstituted Program Advisory Committee to provide public advice
- A draft process for inviting, reviewing, approving and adopting projects
- Preliminary descriptions of the processes for getting advice from experts and the public
- Preliminary data management and information transfer policies

6.1 Public Advice

The importance of public participation in the Trustee Council process, as well as establishment of a public advisory group to advise the trustees, was specifically recognized in the *Exxon Valdez* settlement and is an integral part of the agreement between the state and federal governments. Figure 6.1 illustrates the role of public participation in the GEM program.

The existing Public Advisory Group (PAG) has 17 members representing 12 interest groups and the public at large, as well as two ex-officio members from the Alaska Legislature. The charter for this group must be renewed in January 2003. At that time, it would be appropriate to change the makeup of the PAG to include the participation of additional interests. Preliminary input from the current PAG and from some of the community facilitators representing tribal interests calls for a reconstituted Program Advisory Committee (PAC), representing a broad range of stakeholder interests and communities and including a number of scientists with broad vision and stature.

One possible scenario is a group of 20, with five scientists and 15 community and stakeholder representatives. A decision would need to be made on whether specific seats would be formally designated. This group would meet at least twice a year and provide broad program and policy guidance to the Trustee Council and staff on the overall development and progress of the GEM program. The group would take an active role in setting priorities and ensuring that the overall program is responsive to public interests and needs.



6.2 Program Management and Administration

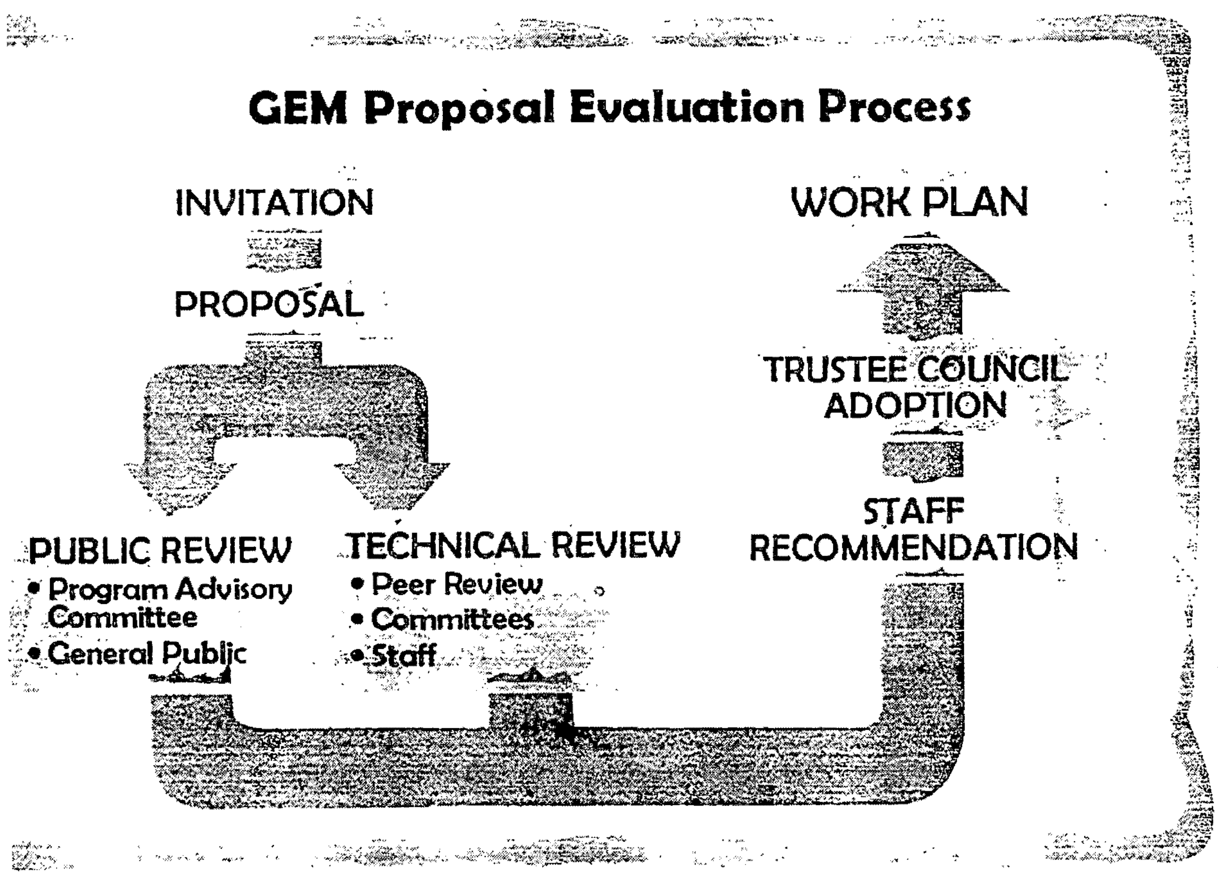
The administration and management of the GEM program must be cost-efficient, have a high degree of scientific credibility, and provide for public access and accountability.

The GEM program will be administered by a core professional staff that is not directly affiliated with any particular agency, institution, or program, as is currently the case with the management of the *Exxon Valdez* Oil Spill Restoration Office. An executive director will oversee the financial, program management and administration, scientific, and public involvement aspects of the program. The executive director and staff, while housed for administrative purposes in a single government agency, will work under a cooperative agreement for all six trustees. The Trustee Council and the staff will receive advice on science and policy matters, including review of monitoring and research activities, from experts and from the public, including the PAC.

6.2.1 Proposal Evaluation Process

The basic work plan process will likely have the following elements or steps, which are also shown in Figure 6.2. As implementation of GEM begins, however, these steps may be modified as efficiencies and improvements are found.

- A "State of the Gulf" workshop will be held periodically, at which the current status of the health of the GOA ecosystem will be assessed. Project investigators, peer reviewers, resource managers, stakeholders, and the public will be invited to this meeting, at which research and monitoring results will be presented and discussed. In some years, this workshop will be replaced by or augmented with a process of consultations and workshops with various committees and work groups of science advisors to evaluate and affirm or revise priorities.
- An *Invitation to Submit Proposals,* which will specify the types of proposals that are priorities for consideration to implement the mission and goals of the GEM program, will be issued periodically. Research proposals are envisioned to be of finite duration and have short-term goals (for example, 2 to 5 years). Monitoring projects will be evaluated and renewed on longer time scales (such as once every 5 years). The *Invitation(s)* will be the vehicle for notifying the scientific community and others that proposals will be considered during a certain period of time. Scientific and public advisors will help provide precision to the specific questions posed in the monitoring plan.
- Proposals received in response to the *Invitation* will be circulated for peer review (see below). Peer review comments and recommendations will be



summarized by staff and provide a basis for preliminary recommendation by the executive director. Proposals will be reviewed for their ability to contribute to the information-gathering needs of the central hypothesis and questions, and also for how they contribute to meeting the programmatic goals and policies of the Trustee Council (see Chapter 1, Volume I), such as promoting community involvement, developing resource management applications, and leveraging funds from other sources. Past performance of principal investigators will be assessed. Staff will also review all budgets. In addition, the comments from the PAC and the general public will be solicited.

- The executive director will develop a recommendation on each proposal based on the peer review, staff review, and public and scientific advice.
- A reasonable period of time for public comment will be built into the proposal review process, including review by the PAC.
- The Trustee Council, after receiving advice from its public and scientific advisors and staff, will vote on which proposals to fund.

6.2.2 The Work Plan

A Work Plan will document the current activities that implement the program. As projects for monitoring and research are approved by the Trustee Council, they will become part of the Work Plan. The Trustee Council may be asked to adopt a new Work Plan each year or they may be asked to adopt new groups of projects into the Work Plan on a periodic basis.

6.2.3 Reports and Publications

Annual and final reports will be required for all monitoring and research projects and will be reviewed to evaluate whether the investigators are making satisfactory progress toward project objectives. Selected annual reports may be sent for peer review. All final reports will be subject to independent peer review, and comments from the independent peer reviewers must be addressed in the final versions of final reports. All annual and final reports will be archived at the Alaska Resources Library and Information Service (ARLIS).

Publications in the peer-reviewed literature will be expected of program participants.

6.2.4 Peer Review

Each project, as well as some annual and all final reports, will be peer-reviewed by appropriate experts identified by staff. The peer review may be either paid or volunteer, whichever is most expeditious and appropriate. These reviews will be conducted by qualified scientists or other experts who are not also conducting projects funded by the Trustee Council. The external technical review process will provide a rigorous critique of the scientific merits of all monitoring and research proposals and selected reports. Review functions may be carried out in writing, by telephone and occasionally on site or in person.

Special review panels may be convened from time to time to evaluate and make recommendations about aspects of the GEM program. At other times, special panels may meet with project investigators and others to fully explore particular topics, problems, or projects. Periodic review by an outside entity, such as the National Research Council, may be appropriate.

6.3 Guidance on GEM Program Development and Implementation

In addition to peer review and public review and advice, a committee and work group approach will be used guide GEM program development and implementation. This approach may include a core committee, subcommittees, and work groups.

6.3.1 Core Committee

The core committee would have four purposes:

1. Provide leadership in identifying and developing testable hypotheses relevant to the central questions of the GEM plan, consistent with the mission, goals and policies of the Trustee Council.
2. Support habitat subcommittees and ad hoc work groups (see below) in identifying and helping implement core variables and core monitoring stations.
3. Help identify and recommend syntheses, models, process studies, and other research activities for the *Invitation to Submit Proposals.*
4. Assist staff in identifying peer reviewers and possibly participate in the peer review.

The core committee would be composed of emeritus and senior scientists and others selected primarily for expertise and leadership in a field of study. The scientists serving on the PAC would also serve on the core committee, as would the chairs of each of the habitat subcommittees (see below). In general, the core committee members would not be principal investigators for GEM projects. Institutional and professional affiliations would also be of interest in selecting members, because connections to other marine science programs entities will be valuable for ensuring collaboration and coordination on GEM program implementation.

6.3.2 Subcommittees

Subcommittees would be organized around the four broad habitat types: watershed, intertidal and subtidal, ACC Current, and offshore (Outer continental shelf and Alaska gyre). The chairs of each subcommittee would serve on the core committee.

The purposes of the subcommittees would be as follows:

- Recommend to the core committee testable hypotheses, items for invitation and peer reviewers in their broad habitat type.
- Identify and help guide implementation of core monitoring stations and variables that are relevant to the key questions and testable hypotheses.
- Possibly conduct peer review on proposals and reports in their broad habitat type.

The subcommittee would be composed of scientists, resource managers, and other experts selected primarily for disciplinary expertise and familiarity with the broad habitat type (watersheds, intertidal and subtidal, ACC, and offshore). Institutional and professional affiliations would also be of interest in selecting members to promote collaboration and cooperation.

6.3.3 Work Groups

Ad hoc work groups may be periodically formed to develop specific products as requested by the core committee and subcommittees._ Work groups could also be charged with solving a particular problem in a finite amount of time.

6.4 Data Management and Information Transfer Policies

Data management and information transfer policies are an integral part of GEM program management. Clear and effective approaches to gathering information and making it widely available in understandable formats are essential to the successful operation of the GEM program. Because the program is a regional program with goals of cooperation, coordination, and integration with existing marine science programs, data policies are to be compatible with, and similar to, existing norms for state, federal, and nongovernmental marine science programs. Whenever possible, existing norms will be adapted or adopted for use by the Trustee Council. Standards adopted by the Federal Geospatial Data Committee (FGDC), GLOBEC, and the EPA's Environmental Monitoring and Assessment Program will be used as starting points for developing GEM data policies. (Options and procedures for data management and information transfer are considered in more detail in Chapter 6, Volume II.)

From the fundamental premises stated here, data policies will evolve to support GEM projects as they are implemented (see Chapter 5, Volume I). In the GEM program working definitions, "data" are basic observations on the state of the system, and "information" is data processed to be both understandable and of immediate use to specialists and the public.

The GEM data policies incorporate 10 broad elements:

1. A commitment to the maintenance and long-term availability of data.

2. Full and open sharing of data at low cost, after verification and validation.
3. Timely availability of data; depending on the type of data. Data will be available almost immediately to 24 months.
4. Availability of data on the GEM public Web site.
5. Identification of the origin of all data with a citation.
6. Adherence to data collection and storage standards.
7. Provision of citations to the GEM Bibliography.
8. Encouragement of active participation in the GEM Web site for all participants
9. Long-term archiving of all data in a designated storage facility
10. Acceptance of and adherence to the data policies as a condition for participation in the GEM program and receipt of funding.

Gulf of Alaska **E**cosystem **M**onitoring and Research Program (GEM)

Volume II
The Historical Legacy: Building Blocks for the Future

Volumes I and II together should be referred to as the GEM Program Document.

Review Draft – July 30, 2001

Exxon Valdez Oil Spill Trustee Council
645 G Street, Suite 401
Anchorage, Alaska 99501
www.oilspill.state.ak.us
restoration@oilspill.state.ak.us
907-278-8012
800-478-7745, within Alaska
800-283-7745, outside Alaska

OVERVIEW OF THE GEM DOCUMENT

The Gulf Ecosystem Monitoring (GEM) Program Document has been prepared in two volumes to more easily describe the basic monitoring and research program (Volume I) while providing access to the factual basis for the program (Volume II). Volume I explains the basic motivations for the program, information needs, and the strategies for meeting these information needs (see Table O.1 below). Volume II presents the factual basis for the program, including the detailed descriptions of two important components of the program: (1) modeling and (2) data management and information transfer. Table O.1 identifies the question addressed by each chapter and the products provided. The Overview Figure, following the table, illustrates the structure of the GEM Program Document.

Table O.1 Contents of the GEM Program Document

Chapter	Title & Question Addressed	Products
Volume I—Strategic Plan for Monitoring and Research		
1	Vision *Why do this and what do we hope to achieve?*	Mission and goals Program context
2	Human Uses and Activities *What are the human activities in the region and their potential impacts?*	Issues of concern to the Trustee Council and public
3	GEM Information Needs *What information do we need?*	Specific questions and information needs
4	Program Components and Strategies *How can we get the information we need?*	Key components and implementation strategies
5	Monitoring Plan & Research Agenda *What are we going to do to get the information, when will we do it, and with whom?*	Starting point for implementation process
6	Program Management *What are the processes and policies for monitoring and research?*	The Gulf Ecosystem Monitoring and Research Program
Volume II—The Historical Legacy: Building Blocks for the Future		
1	Building on Lessons of the Past *What do other regional marine science programs have to teach us?*	Past experience Hypotheses and strategies
2	Lingering Effects of the Oil Spill *What does experience from the oil spill teach us?*	Past experience
3	Scientific Background *What is published that can help us?*	Current knowledge of the Gulf of Alaska General research questions

Table O.1 Contents of the GEM Program Document

Chapter	Title & Question Addressed	Products
4	Conceptual Foundation *How do we think the ecosystem works?*	Central hypothesis and questions
5	Modeling *What is the role of modeling in GEM implementation?*	Modeling definitions and options for program implementation
6	Data Management and Information Transfer *What are the roles of data management and information transfer in GEM implementation?*	Data management and information transfer options for program implementation
A	Appendix A. Fish and Invertebrate Species from 1996 Trawl Survey of the Gulf of Alaska	
B	Appendix B. North Pacific Models of the Alaska Fisheries Science Center and Selected Other Organizations	
C	Appendix C. Gulf Ecosystem Monitoring and Research (GEM) Database	
D	Appendix D. Glossary of Existing Agency Programs and Projects	
E	Appendix E. Acronyms and Web Links	

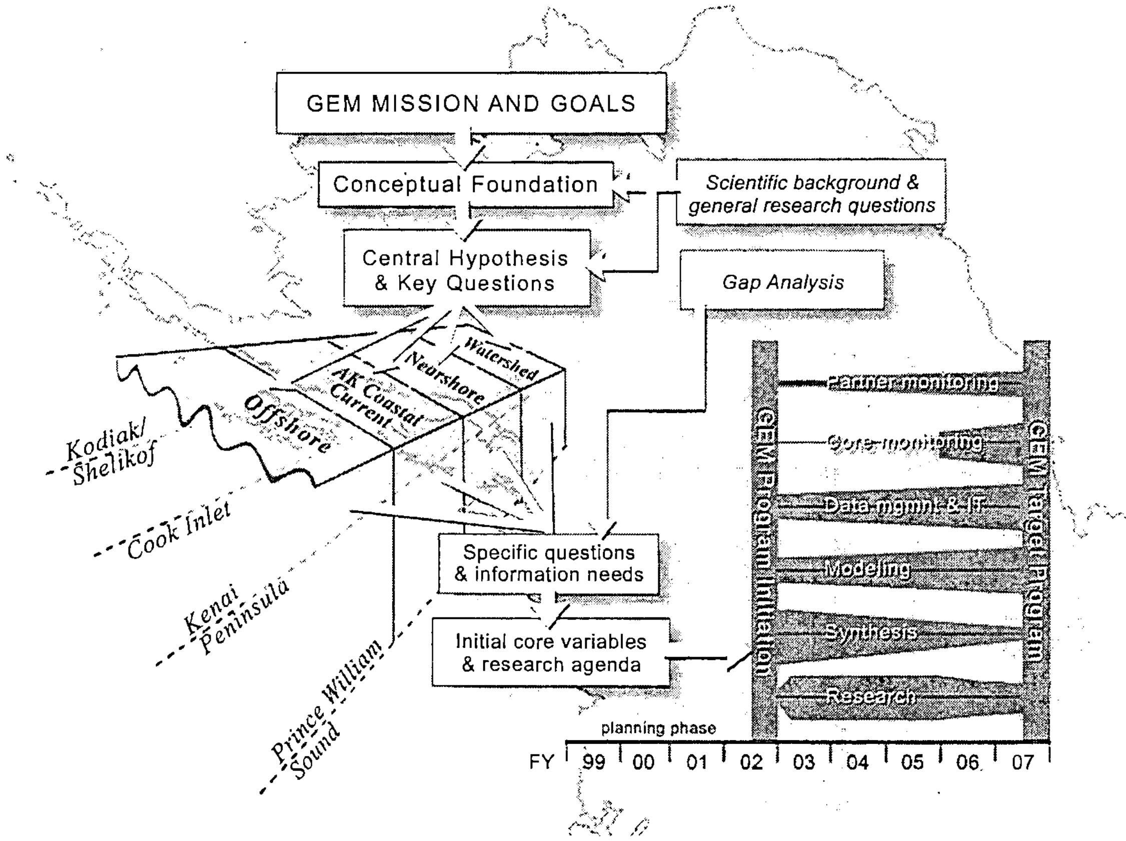


Figure O.1. An overview of the structure of the GEM program document showing the relation of key concepts to the habitat types and the schedule of implementation

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VOLUME II

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Appendices

1. BUILDING ON THE LESSONS OF THE PAST

In This Chapter

- Background on other relevant programs
- Studies supported by Trustee Council funding

The GEM program is not the first attempt to look at large areas of Alaska's marine ecosystems from a broader perspective. The *Exxon Valdez* Oil Spill Restoration Program, as well as a number of other programs, provides valuable guidance.

As explained in Volume I, long-term environmental monitoring and ecosystem studies will be designed to increase our understanding of the biological processes of the spill area ecosystem in the context of natural forces and human activities.

1.1 Alaska Regional Marine Research Plan (1993)

The *Alaska Regional Marine Research Plan* (ARMRP) (1993) is a marine science planning document with a broad geographic scope that was prepared under the U.S. Regional Marine Research Act of 1991. For all marine areas of Alaska, including the GOA, the plan provided five elements of interest to the GEM program:

1. An overview of the status of marine resources;
2. An inventory and description of current and anticipated marine research;
3. A statement of short- and long-term marine research needs and priorities;
4. An assessment of how the research and monitoring activities under the program take advantage of existing projects; and
5. Descriptions, time tables, and budgets for research and monitoring to be conducted under the program.

Goals of other major programs are relevant to the GEM effort.

ARMRP goals express the scientific needs of the Alaska region as of 1992 and are still relevant to the GEM effort because they will accomplish the following:

- Distinguish between natural and human-induced changes in marine ecosystems of the Alaska region;

- Distinguish between natural and human-induced changes in water quality of the Alaska region;
- Stimulate the development of a data gathering and sharing system that will serve scientists in the region from government, academia, and the private sector in dealing with water quality and ecosystem health issues; and
- Provide a forum for enhancing and maintaining broad discussion among the marine scientific community on the most direct and effective way to understand and address issues related to maintaining the health of the water quality and ecosystem health in the region.

1.2 Bering Sea Ecosystem Research Plan (1998)

The Bering Sea has received a good deal of attention because of concern about long-term declines in populations of high-profile species such as king and tanner crab, Steller sea lions, spectacled eider, Steller's eider, common murres, thick-billed murres, and red-legged and black-legged kittiwakes (DOI et al. 1998b). The GEM mission statement is consistent with the vision of the federal-state regulatory agencies for the *Bering Sea Ecosystem Research Plan* (DOI et al. 1998a), which follows: "We envision a productive, ecologically diverse Bering Sea ecosystem that will provide long-term, sustained benefits to local communities and the nation." The basic concepts of the GEM program are also consistent with the overarching hypotheses of the Bering Sea plan:

- Natural variability in the physical environment causes shifts in trophic (food web) structure and changes in the overall productivity of the Bering Sea.
- Human impact leads to environmental degradation, including increased levels of contaminants, loss of habitats, and increased mortality on certain species in the ecosystem that may trigger changes in species composition and abundance.

In addition, four of the research themes of the Bering Sea plan–variability and mechanisms in the physical environment, individual species responses, food web dynamics, and contaminants and other introductions—are closely aligned with the conceptual foundation of the GEM program (see Chapter 4, Volume II). Current research programs for the Bering Sea (DOI et al. 1997) often overlap with the programs identified in the database of ongoing and historical GOA projects (discussed in Chapter 4, Section 4, Volume I).

1.3 GLOBEC (1991 to Present)

The Scientific Committee on Oceanic Research (SCOR) and the Intergovernmental Oceanographic Commission (IOC) established the Global Ocean Ecosystem Dynamics (GLOBEC) program in late 1991. GLOBEC is the core project of the International Geosphere-Biosphere Programme responsible for understanding how global change will affect abundance, diversity, and productivity of marine populations. The program focuses on the regulatory control of zooplankton dynamics on the biomass of many fish and shellfish.

The GLOBEC Science Plan (U.S. GLOBEC 1997) describes an approach that uses a combination of field observations and modeling to concentrate on the middle and upper trophic levels of the ecosystem. The GLOBEC goal is as follows: "To advance our understanding of the structure and functioning of the global ocean ecosystem, its major subsystems, and its response to physical forcing so that a capability can be developed to forecast the responses of the marine ecosystem to global change."

The overarching concept is that marine and terrestrial ecosystems have close connections among energy flow, chemical cycling, and food web structure. GEM monitoring activities will be consistent with these additional GLOBEC concepts:

- Changes in abundances of birds, fish, shellfish, and mammals (higher trophic levels) usually reflect changes in physical and chemical processes;
- The actual effects on abundances of higher trophic level animals may depend on how these physical and chemical changes act on food production through effects on lower trophic level species;
- Changes in the dominant species at each trophic level are consistent with changes in the physical and chemical systems; and
- Understanding how the dominant species at each trophic level change through time requires knowledge of the energy and nutrient budgets of the ecosystem.

1.4 Scientific Legacy of the *Exxon Valdez* Oil Spill (1989 to 2002)

Ecological knowledge gained in the years following the 1989 EVOS forms a substantial portion of the foundation of the GEM program. The recovery status of each affected resource is based to the extent possible on knowledge of the resource's role in the ecosystem. The Trustee Council's scientific legacy creates the need to understand the causes of population trends in individual species of plants and animals through time and the need to distinquish human impacts from those of climate and interactions with related species.

The studies supported by the Trustee Council since 1989 include more than 1,60 damage assessment studies costing more than $100 million, as well as hundreds of restoration studies costing approximately $170 million. These studies have resulted in more than 400 peer-reviewed scientific publications, including numerous dissertations and theses. In addition, hundreds of peer-reviewed project reports are available through the Alaska Resources Library and Information Services (ARLIS) and state and university library systems. Many final reports are available in electronic format through the Trustee Council offices or ARLIS. A current electronic bibliography of scientific publications sponsored by the Trustee Council is available on its Web site (www.oilspill.state.ak.us) or on request to the Trustee Council (EVROTCB 2001). A list of Trustee Council projects, as well as a complete list of final and annual project reports, also is available on the Web site or on request (EVROFAB 2001).

In addition to much specific information on the effects of oil on the plant and animal life in the spill area, the studies also provide a wealth of ecological information. Most prominent among the Trustee Council's studies are three ecosystem-scale projects, known by their acronyms: SEA, NVP, and APEX.

The Sound Ecosystem Assessment (SEA) is the largest of the three studies. Funded at $22 million for a seven-year period, SEA brought together a team of scientists from many different disciplines to understand the biological and physical factors responsible for producing herring and salmon in PWS. When completed, the data collected during SEA are expected to form the basis of numerical models capable of simulating the oceanographic processes that influence the survival and productivity of juvenile pink salmon and herring in PWS. SEA has already provided new insights into the critical factors that influence fisheries production, including ocean currents, nutrient levels, mixing of water masses, salinity, and temperatures. These observations have made it possible to model how physical factors influence production of plant and animal plankton, prey, and predators in the food web.

The Nearshore Vertebrate Predator (NVP) project is a six-year, $6.5 million study of factors limiting recovery of two fish-eating species, river otters and pigeon guillemots, and two invertebrate-eating species that inhabit nearshore areas, harlequin ducks and sea otters. The project looked at oil exposure, as well as natural factors such as food availability, as potential factors in the recovery of these indicator species, and has contributed to increased understanding of the linkages between terrestrial and marine ecosystems (see Chapter 3, Section 2, Volume II).

The Alaska Predator Ecosystem Experiment (APEX) is an eight-year, $10.8 million study of ecological relations among seabirds and their prey species. The APEX project explored the critical connection between productivities of marine bird populations and forage fish species, in an attempt to understand how wide-ranging ecological changes might be related to fluctuating seabird populations. In addition, analyzing the food of marine birds shows promise in providing abundance estimates for key fish species, such as sand lance and herring.

The following topics also have been covered by other Trustee Council-funded studies and the results are available in published scientific literature:

- Physical and biological oceanography;
- Marine food web structure and dynamics;
- Predator-prey relationships among birds, fish, and mammals;

- The source and fate of carbon among species;
- Developmental changes in trophic level within species;
- Marine growth and survival of salmon;
- Intertidal community ecology; and
- Early life history and stock structure in herring.

Many studies have focused on key individual species injured by the oil spill, including pink and sockeye salmon, cutthroat trout, Pacific herring, black oystercatchers, river otters, harbor seals, mussels, and kelp.

One of the most extensive series of single-species investigations is the $14 million suite of pink salmon studies. These include monitoring the toxic effect of oil, conducting genetic studies related to survival, and supplementing select populations. Another extensive series of studies was done on Pacific herring. Roughly $6 million has been spent on the restoration of Pacific herring in addition to the funding for the herring component of SEA. Since the crash of 1993, the population has yet to recruit a highly successful post-spill year-class. Current investigative strategies are focused on the full range of causes of the crash, such as disease and ecological factors, including the effects of oceanographic processes on year-class strength and adult distribution.

More than $5 million has been spent on the restoration of marine mammals, primarily harbor seals, a major source of subsistence food in the diet of Native Alaskans in the northern GOA. Harbor seal populations were declining before the spill, took a big hit at the time of the spill event, and have continued to decline ever since, although the rate of decline seems to have slowed. Food availability is the major focus of current research, because disease and other factors have been ruled out as causes.

1.5 References

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2. LINGERING EFFECTS OF THE *EXXON VALDEZ* OIL SPILL

In This Chapter

- Description of the *Exxon Valdez* oil spill
- Background of restoration funding
- Concerns and how they are being addressed

On March 24, 1989, the *T/V Exxon Valdez* ran aground on Bligh Reef in PWS, spilling almost 11 million gallons of North Slope crude oil. The event was the largest tanker spill in U.S. history, contaminating about 1,500 miles of Alaska's coastline, killing birds, mammals and fish, and disrupting the ecosystem in the path of the spreading oil.

In 1991 Exxon Corporation agreed to pay the United States and the State of Alaska $900 million over 10 years to restore, replace, enhance, or acquire the equivalent of natural resources injured by the spill, and the reduced or lost human services they provide (United States of America and State of Alaska 1991). Under the court-approved terms of the settlement, the Trustee Council was formed to administer the restoration funds. Twelve years after the spill, total recovery has still not been achieved. Table 2.1 lists resources and the status of their recoveries.

There are two main concerns about the lingering effects of oiling from the 1989 EVOS. The first is the potential effect of pockets of residual oil in the environment. Laboratory studies have shown that contact with petroleum hydrocarbons from weathered oil, even in very small amounts, can kill or harm early life stages of pink salmon and Pacific herring. It is not yet known, however, whether such effects are actually occurring to any significant degree in PWS or at other localities with residual oil. Tissue samples from higher vertebrates, such as sea otters and harlequin ducks, also indicate possible ongoing exposure to petroleum hydrocarbons in PWS. The effects of this exposure are not well established at the level of individual animals or at the population level.

The second concern is the ability of populations to fully recover by overcoming the changes in the population dynamics resulting from the initial oil-related mortalities and the interaction of these effects with those of other kinds of changes and disturbances in the marine ecosystem. Changes in population dynamics are indicated by changes in the age distribution in the population or abundance, among other metrics. Sea otters around northern Knight Island are an example of a species that have experienced prolonged changes in population dynamics in

Table 2.1. Status of Resources Injured by the *Exxon Valdez* Oil Spill as of March 1999

Not Recovering	Recovering	Recovered	Recovery Unknown
Common loon	Archaeological resources	Bald eagle	Cutthroat trout
Cormorants (3 species)	Black oystercatcher	River otter	Designated Wilderness Areas
Harbor seal	Clams		Dolly Varden
Harlequin duck	Common Murre		Kittlitz's murrelet
Killer whale (AB pod)	Intertidal communities		Rockfish
Pigeon guillemot	Marbled murrelet		
	Mussels		
	Pacific herring		
	Pink salmon		
	Sea otter		
	Sediments		
	Sockeye salmon		
	Subtidal communities		

The following injured human services are considered to be recovering: commercial fishing, passive use, recreation and tourism, and subsistence.

the heavily oiled western portion of PWS. The combined effects of the oil spill and the 1998 El Niño event on abundance of common murres in the Barren Islands is an example of possible interactive, or cumulative, impacts. Another example is how the negative impacts of changes in the availability of forage fishes may have combined with oil-related mortalities to interfere with the rate of recovery of seabirds, such as the pigeon guillemot.

During the next several years, studies of lingering oil spill injury and recovery will increasingly be incorporated in long-term environmental monitoring and ecosystem studies. These long-term studies are expected to increase our understanding of the biological processes of the spill area ecosystem in the context of natural forces and human activities, including the oil spill. Some oil-spill-monitoring activities, (such as residual oil in the environment) may be repeated periodically as may be indicated by information developed in the long-term studies.

Long-term environmental monitoring and ecosystem studies will be designed to increase our understanding of the biological processes of the spill area ecosystem in the context of natural forces and human activities.

When evaluating lingering effects of the oil spill, it is important to bear in mind that not all scientific results from the NRDA and Trustee Council investigations are available yet. Although the oil spill occurred more than a decade ago, results of studies are still being published on a regular basis. The Trustee Council database of peer-reviewed publications and theses resulting from its oil spill investigations currently contains more than 400 citations

(EVROTCB 2001). New publications from oil spill investigations are expected for at least the next three years. In addition, much additional detailed data that cannot be published in peer-reviewed literature because of space limitations is being added in the form of final reports from oil spill investigations (EVROFAB 2001). It will be a number of years after the completion of the oil spill restoration investigations before this information is fully available.

2.1 References

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3. SCIENTIFIC BACKGROUND

In This Chapter

- Description of the scientific understanding of the Gulf of Alaska
- Identification of physical, chemical, and biological characteristics
- Discussion of changes in populations, predators, and prey

NOTE: An executive summary will be added at the beginning of this chapter.

3.1 The Gulf of Alaska

The GOA encompasses watersheds and waters south and east of the Alaska Peninsula from Great Sitkin Island (176° W), north of 52° N to the Canadian mainland on Queen Charlotte Sound (127° 30' W). Twelve and a half percent of the continental shelf of the United States lies within GOA waters (Hood 1986).

The area of the GOA directly affected by the EVOS (Figure 3.1) encompasses broadly diverse terrestrial and aquatic environments. Within the four broad habitat types of the watersheds, intertidal-subtidal, Alaska Coastal Current (ACC), and offshore (continental shelf break and Alaska Gyre), the geological, climatic, oceanographic, and biological processes interact to produce the highly valued natural beauty and bounty of this region.

Human uses of the GOA are extensive. The GOA is a major source of food and recreation for the entire nation, a source of traditional foods and culture for indigenous peoples, and a source of food and enjoyment for all Alaskans. Serving as a "lung" of the planet, GOA resources are part of the process that provides oxygen to the atmosphere. In addition, the GOA provides habitat for diverse populations of plants, fish, and wildlife and is a source of beauty and inspiration to those who love natural things.

The eastern boundary of the GOA is a geologically young, tectonically active area that contains the world's third largest permanent icefield, after Greenland and Antarctica. Consequently, the watersheds of the eastern boundary of the GOA lie in a series of steep, high mountain ranges. Glaciers head many watersheds in this area, and the eastern boundary mountains trap weather systems from the west, making orographic, or mountain-directed, forcing important in shaping the region's climate. From the southeastern GOA limit (52° N at landfall) moving north, the eastern GOA headwater mountain ranges and height of the highest peaks are the Pacific Coast (10,290 feet [ft]), St. Elias (18,000 ft), and Wrangell

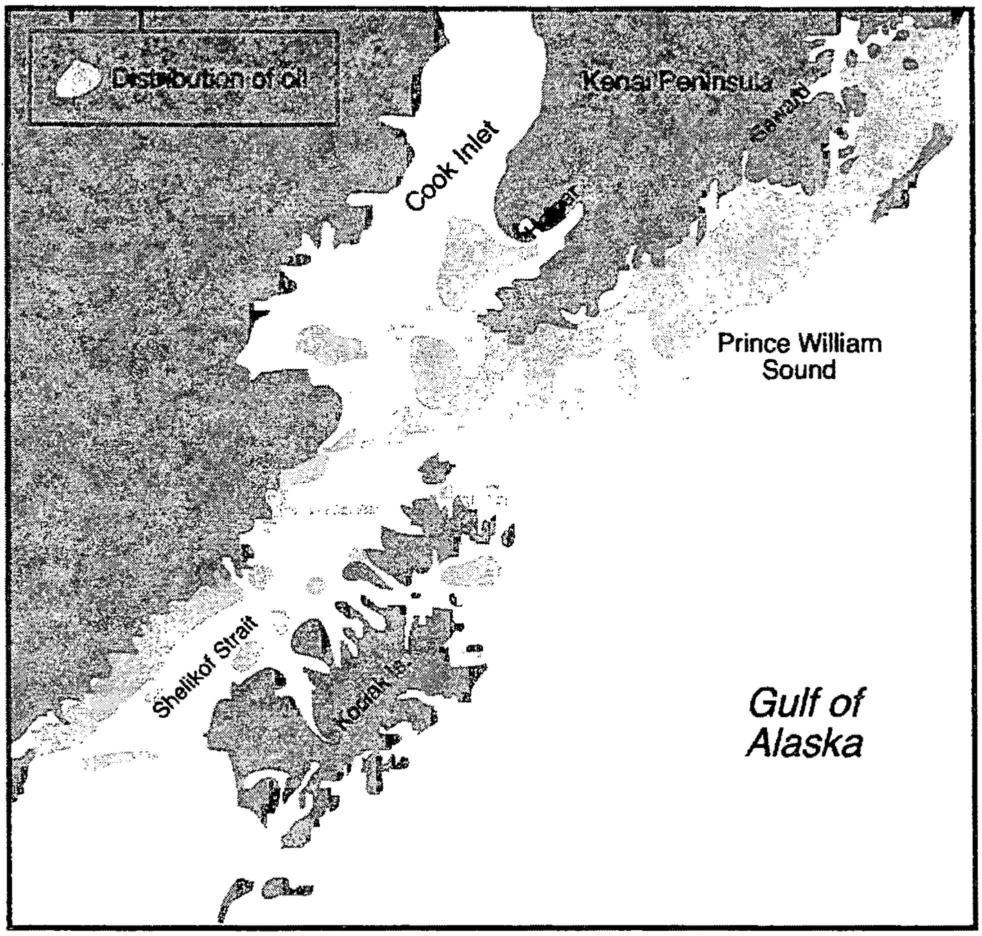


Figure 3.1 Distribution of oil from the *Exxon Valdez* oil spill.

(16,390 ft). Northern boundary mountain ranges from east to west are the Chugach (13,176 ft), Talkeetna (8,800 ft), and Alaska (20,320 ft). The western boundary of the GOA headwaters is formed in the north by the Alaska Range and to the south-southwest by the Aleutian Mountains (7,585 ft).

Relatively few major river systems manage to pierce the eastern boundary mountains, although thousands of small independent drainages dot the eastern coastline and islands of the Inside Passage. Major eastern rivers from the south moving north to the perimeter of PWS are the Skeena and Nass (Canada), the Stikine, Taku, Chilkat, Chilkoot, Alsek, Situk, and Copper. All major and nearly all smaller watersheds in the GOA region support anadromous fish species. For example, although PWS proper has no major river systems, it does have more than 800 independent drainages that are known to support anadromous fish species.

To the west of PWS lie the major rivers of Cook Inlet. Two major tributaries of Cook Inlet, the Kenai and the Kasilof, originate on the Kenai Peninsula. The Kenai Peninsula lies between PWS, the northern GOA and Cook Inlet. Cook Inlet's largest northern tributary, the Susitna River, has headwaters in the Alaska Range on the slopes of North America's highest peak, Mt. McKinley. Moving southwest down the Alaska Peninsula, only two major river systems are found on the western coastal boundary of the GOA, the Crescent and Chignik, although many small coastal watersheds connected to the GOA abound. Kodiak Island, off the coast of the Alaska Peninsula, has a number of relatively large river systems, including the Karluk, Red, and Frazer.

The nature of the terrestrial boundaries of the GOA is important in defining the processes that drive biological production in all environments. As described in more detail below, the ice cap and the eastern boundary mountains create substantial freshwater runoff that controls salinity in the nearshore GOA and helps drive the eastern boundary current. The eastern mountains slow the pace of and deflect weather systems that influence productivity in freshwater and marine environments.

The GOA shoreline is bordered by a continental shelf ranging to 200 meters (m) in depth (Figure 3.2). Extensive and spectacular shoreline has been and is being shaped by plate tectonics and massive glacial activity (Hampton et al. 1986). In the eastern GOA, the shelf is variable in width from Cape Spencer to Middleton Island. It broadens considerably in the north between Middleton Island and the Shumagin Islands and narrows again through the Aleutian Islands. The continental slope, down to 2,000 m, is very broad in the eastern GOA, but it narrows steadily southwestward of Kodiak, becoming only a narrow shoulder above the wall of the deep Aleutian Trench just west of Unimak Pass. The continental shelf is incised by extensive valleys or canyons that may be important in cross-shelf water movement (Carlson et al. 1982), and by very large areas of drowned glacial moraines and slumped sediments (Molnia 1981).

Figure 3.2 Satellite radar image of the northern Gulf of Alaska. Continental shelf, seamounts, and abyssal plain can be seen in relief. (Composite image from Sea-viewing Wide Field-of-view Sensor [SeaWiFS], a National Aeronautics and Space Agency remote-sensing satellite.)

3.2 Climate

3.2.1 Introduction

The weather in the northern GOA, and by extension that of adjacent regions such as PWS, is dominated for much of the year by extratropical cyclones. These storms typically form well to the south and east of the region over the warm waters of the central North Pacific Ocean and propagate northwestward into the cooler waters of the GOA (Luick et al. 1987, Wilson and Overland 1986). Eventually these storms make landfall in Southcentral or South east Alaska where their further progress is impeded by the extreme terrain of the Saint Elias Mountains and other coastal ranges. In fact, weather forecasters call the coastal region between Cordova and Yakutat "Coffin Corner," in reference to the frequency of decaying extratropical storms found there.

The high probability of cyclonic disturbances in the northern GOA is significant to the local weather and climate of PWS. Associated with these storms are large offshore-directed, low-level pressure gradients (tightly packed isobars roughly parallel to the coast). Depending on other factors (such as static stability, upper-level wind profile) these gradients can produce strong gradient-balance winds parallel to the coastline or downslope (offshore-directed) wind events (Macklin et al. 1988). Further, because of the complex glacially sculptured nature of the terrain in PWS, several regions experience significant upslope winds in certain favorable storm situations. This wind configuration, in concert with steep terrain and nearly saturated, low-level air masses, produces the local extreme in precipitation responsible for tidewater glaciers of PWS.

The combination of general storminess, significant windiness (and concomitant wave generation), and orographically enhanced precipitation are essential features of the northern GOA and PWS, and have a strong impact on the variety and composition of the biota this region supports. In addition, the annual melting of seasonal snowfall accumulations, in combination with glacial ablation, is responsible for the bulk freshwater input into PWS. In this context, any changes in climate–naturally induced or anthropogenic–that substantively alter the frequency and duration of these common yet transient weather features should also affect related parts of the region ecosystem. In the following discussion, the factors responsible for climate change are identified and explained on a general level in preparation for specific relationships among climate, physical, and chemical oceanography; species; and groups of species that follow. Climate is recognized to be a major natural force influencing change in biological resources.

The GEM mission is to promote, "... greater understanding of how its productivity is influenced by natural changes and human activities" (EVOSTC 2000). Climatic forcing is an important natural agent of change in the region's populations of birds, fish, mammals, and other plant and animal species (Hare et al. 1999, Mantua et al. 1997, Anderson and Piatt 1999, Francis et al. 1998). Human activities, or anthropogenic forcing, may have profound effects on climate. There is growing evidence that human activities producing "greenhouse gases" such as carbon dioxide may contribute to global climate change by altering the global carbon cycle (Sigman and Boyle 2000, Allen et al. 2000). Understanding how natural and human forcing influences biological productivity requires knowledge of the major determinants of climate change described in this section.

Climate in the GOA results from the complex interactions of geophysical and astrophysical forces, and also in part by biogeochemical forcing. Physical processes acting on the global carbon cycle and its living component, the biological pump, drive oscillations in climate (Sigman and Boyle 2000). The most prominent geophysical feature associated with climate change in the GOA is the Aleutian Low Pressure system (Wilson and Overland 1986). The location and intensity of this system affects storm tracks, air temperatures, wind velocities, ocean currents and other key physical factors in the GOA and adjacent land areas. Sharp variations, or oscillations, in the location and intensity of the Aleutian Low are the result of physical factors operating both proximally and at great distances from the GOA (Mantua et al. 1997). Periodic changes in the location and intensity of the Aleutian Low are related to movements of adjacent continental air masses and the jet stream to oceanography and weather in the eastern tropical Pacific.

Astrophysical forces contribute to long-term trends and periodic changes in the climate of the GOA by controlling the amount of solar radiation that reaches earth, or insolation (Rutherford and D'Hondt 2000). Climate also depends on the amount of global insolation and the proportion of the insolation stored by the atmosphere, oceans, and biological systems (Sigman and Boyle 2000). Changes in climate and biological systems occur through physical forcing of controlling factors, such as solar radiation, strength of lunar mixing of water masses, and patterns of ocean circulation. Periodic variations in the earth's solar orbit, the speed of rotation and orientation of the earth, and the degree of inclination of the earth's axis in relation to the sun result in periodic changes in climate and associated biological activity.

Understanding climatic change requires sorting out the effects of physical forcing factors that operate simultaneously at different periods. Periodicities of physical forcing on factors potentially controlling climate and biological systems include are 100,000 years, 41,000 years, 23,000 years, 10,000 years, 20 years, 18.6 years, and 10 years, among many others. For example, Minobe (1999) identified periods of 50 and 20 years in an analysis of the North Pacific Index (NPI) (Figure 3.3) (Minobe 1999)). The NPI is a time series of geographically averaged sea-level pressures representing a univariate (depending on only one random variable) measure of location for the Aleutian Low (Trenberth and Hurrel 1994).

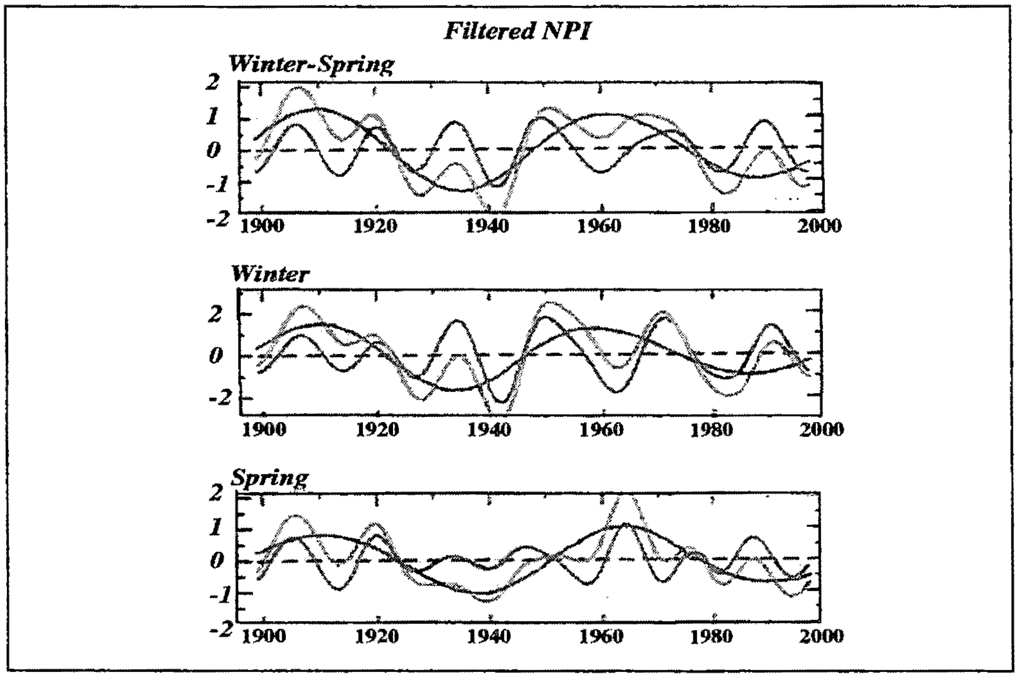


Figure 3.3 Filtered NPI (top) in the winter-spring, winter, and spring seasons. NPI is shown in hectoPascals, a measure of barometric pressure at sea level. The green curves indicate the 10- to 80-year, band-pass filtered NPI data; the red curves indicate the 10- to 30-year, band-pass filtered (bidecadal filtered) NPI data, and the blue curves indicate the 30- to 80-year, band-pass filtered NPI data. Source: Minobe 1999.

Advances and retreats of icefields and glaciers mark major changes in weather and biology. Changes in the seasonal and geographic distribution of solar radiation are thought to be primarily responsible for the periodic advance and recession of glaciers during the past 2 million years (Hays et al. 1976). The amount of solar radiation reaching earth changes periodically, or oscillates, in response to variations in the path of the earth's orbit about the sun. Geographic and seasonal changes in solar radiation caused by periodic variations in the earth's orbit around and orientation toward the sun have been labelled "Milankovich cycles," which are known to have characteristic frequencies of 100,000, 41,000, and 23,000 years (Berger et al. 1984). Shifts in the periodicity of long-term weather patterns correspond to shifts from one Milankovich cycle to another. How and why shifts from one Milankovich cycle to another occur are among the most important questions in paleoeclimate research (Hays et al. 1976, Rutherford and D'Hondt 2000).

3.2.2 Long Time Scales

3.2.2.1 Orbital Eccentricity and Obliquity

Shifts in the periodicity of glaciation from 41,000 to 100,000 years between 1.5 and 0.6 million years before present (Myr bp) emphasize the importance of the atmosphere and oceans in translating the effects of physical forcing into weather cycles. Glacial cycles may have initially shifted from the 41,000-year period of the "obliquity cycle" to the 100,000-year period of the "orbital eccentricity" perhaps caused initially by changes in the heat flux, from the equator to the higher latitudes (Rutherford and D'Hondt 2000). (Obliquity is the angle between the plane of the earth's orbit and the equatorial plane.) According to the theory advanced by Rutherford and D'Hondt (2000), interactions between long-period physical forcing (Milankovich cycles) and shorter-period forcing (precession) may have been a key factor in lengthening the time period between glaciations in the transition period of 1.5 and 0.6 Myr bp. Transitions from glacial to interglacial periods may be triggered by factors such as the micronutrient iron (Martin 1990) that control the activity of the biological pump in the Southern Ocean, described below.

Theories about regulation of heat flux from the equator to northern latitudes are central to understanding climate change. For example, the heat flux that occurs when the Gulf Stream moves equatorial warmth north to surround the United Kingdom, Iceland, and Northern Europe defines comfortable human life styles in these countries. Anything that disrupts this heat flux process would drastically alter climate in Northern Europe.

3.2.2.2 Day Length

Day length is increasing by one to two seconds each 100,000 years primarily because of lunar tidal action (U.S. Naval Observatory [USNO]). Understanding the role of day length in climate variation is problematic because the rotational speed of the earth cannot be predicted exactly due to the effects of a large number of poorly understood sources of variation (USNO). Short-term effects are probably inconsequential biologically, because variations in daily rotational speed are very small, but cumulative effects could be more substantial in the long term.

3.2.2.3 Carbon Cycling and the Biological Pump

Changes in the amount of solar radiation available to drive physical and biological systems on earth are not the only causes of climate oscillations in the GOA, or elsewhere in earth. Of critical importance to life on earth, changes in insolation result in changes in the amount of a "greenhouse gas," carbon dioxide in the atmosphere resulting from changes in physical properties, such as ocean temperature, and due to biological processes collectively known as the biological pump (Chisholm 2000). The importance of the biological pump in determining levels of atmospheric carbon dioxide is thought to be substantial, since the direct physical and chemical effects of changes in insolation on the carbon cycle alone (Sigman and Boyle 2000) (Figure 3.4) are not sufficient to account for the magnitude of the changes in atmospheric carbon dioxide between major climate changes, such as glaciations

The Biological Pump. Photosynthesis and respiration by marine plants and animals play key roles in the global carbon cycle by "pumping" carbon dioxide from the atmosphere to the surface ocean and incorporating it into organic carbon during photosynthesis. Organic carbon not liberated as carbon dioxide during respiration is "pumped" (exported) to deep ocean water where bacteria convert it to carbon dioxide. Over a period of about 1,000 years, ocean currents return the deep water's carbon dioxide to the surface (through upwelling) where it again drives photosynthesis and ventilates to the atmosphere. The degree to which this deep-water's carbon dioxide is "pumped" back into the atmosphere or "pumped" back into deep water depends on the intensity of the photosynthetic activity, which depends on availability of the macronutrients phosphate, nitrate, and silicate, and on micronutrients such as reduced iron (Chisholm 2000).

Areas where nitrates and phosphates do not limit phytoplankton production, such as the Southern Ocean (60° S), can have very large effects on the global carbon cycle through the action of the biological pump. When stimulated by the micronutrient iron, the biological pump of the Southern Ocean becomes very strong because of the presence of ample nitrate and phosphate to fuel photosynthesis, as demonstrated by the Southern Ocean iron release experiment (SOIREE) at 61° S 140° E in February 1999 (Boyd et al. 2000). SOIREE stimulated phytoplankton production in surface waters for about two weeks fixing up to 3,000 metric ton (mt) of organic carbon. Although it has not been demonstrated that "iron fertilization" increases export of carbon to deep waters (Chisholm 2000), it clearly does enhance surface production. The Southern Ocean and much of the GOA share the quality of being "high nitrate, low chlorophyll" (HNLC) waters, so it is tempting to speculate that iron would play an important role in controlling production, if not export production, in the GOA.

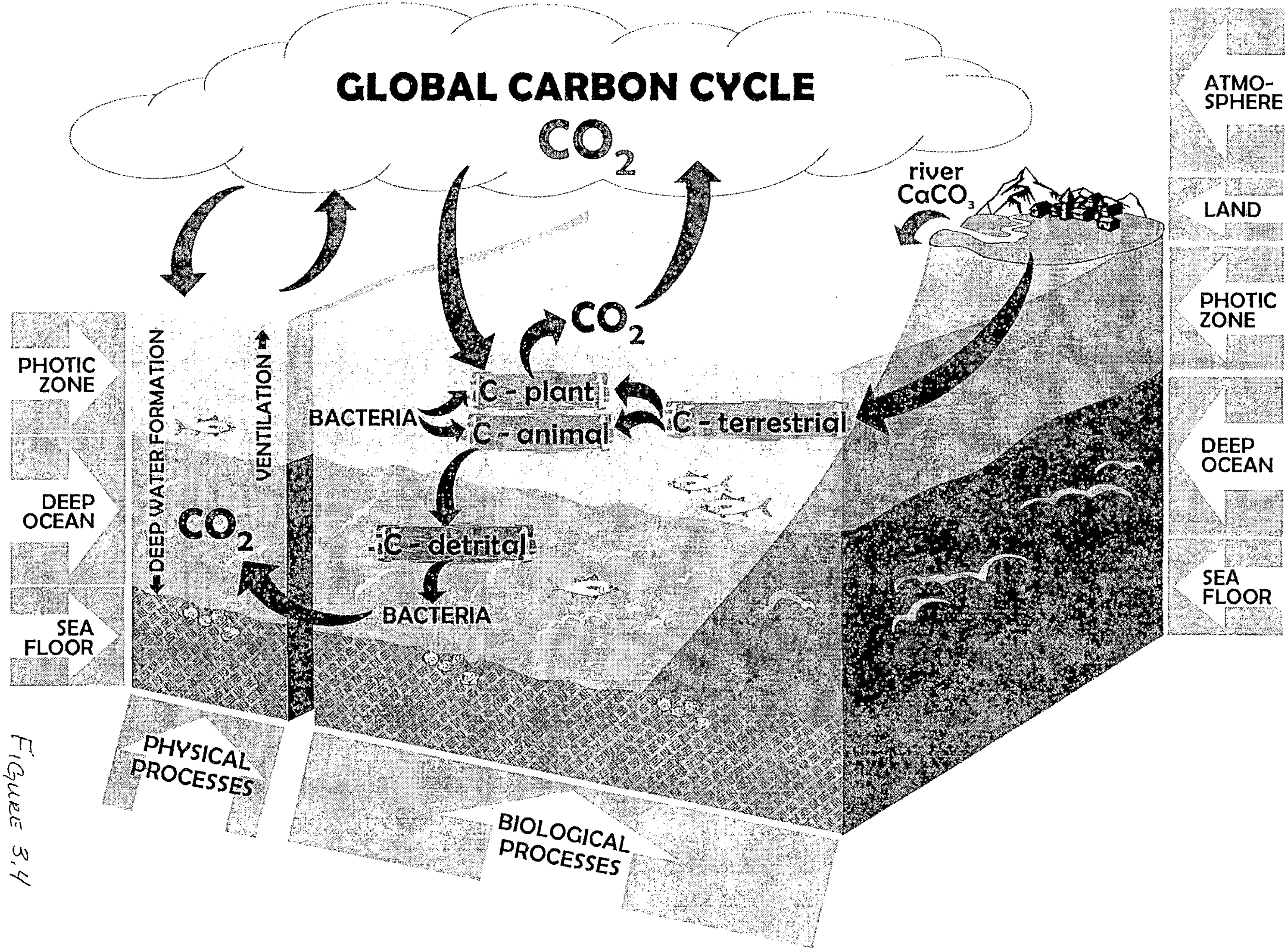

GLOBAL CARBON CYCLE
CO_2
river $CaCO_3$
ATMOSPHERE
LAND
PHOTIC ZONE
DEEP OCEAN
SEA FLOOR
CO_2
C - plant
C - animal
C - terrestrial
BACTERIA
C - detrital
BACTERIA
CO_2
DEEP WATER FORMATION
VENTILATION
PHOTIC ZONE
DEEP OCEAN
SEA FLOOR
PHYSICAL PROCESSES
BIOLOGICAL PROCESSES

Figure 3.4

The Carbon Cycle. An accounting of changes in the amount of carbon in each component of the earth's terrestrial and ocean carbon cycles (Sigmon and Boyd, Figure 3.4), as influenced and represented by the physical and chemical factors of ocean temperature, dissolved inorganic carbon, ocean alkalinity, and the deep reservoir of the nutrients phosphate and nitrate, has to incorporate changes in the strength of the ocean's biological pump to be complete (Sigman and Boyle 2000). The amount of atmospheric carbon dioxide decreases during glacial periods. Because physical-chemical effects do not fully account for these changes, the ruling hypothesis is that the biological pump is stronger during glaciations. But why would the biological pump be stronger during glaciations?

Two leading theories explain decreases in atmospheric carbon dioxide by means of increased activity in the ocean's biological pump during glaciations (Sigman and Boyle 2000). Both theories explain how increased export production of carbon from surface waters to long-term storage in deep ocean waters can lower atmospheric carbon dioxide during glacial periods. The Broecker theory develops mechanisms based on increasing export from low- to mid-latitude surface waters (Broecker 1982, McElroy 1983), and the second theory relies on high-latitude export production of direct relevance to the GOA. Patterns and trends in nutrient use in high-latitude oceans, such as the GOA, where nutrients usually do not limit phytoplankton production, could hold the key to understanding climate oscillations.

3.2.2.4 Ocean Circulation

Because of the heat energy stored in seawater, oceans are vast integrators of past climatic events, as well as agents and buffers of climate change. Wind, precipitation, and other features of climate shape surface ocean currents (Wilson and Overland 1986), and ocean currents in turn strongly feed back into climate. Deep ocean waters driven by thermohaline circulation in the Atlantic and southern oceans influence air temperatures over these portions of the globe by transporting and exchanging large quantities of heat energy with the atmosphere (Peixoto and Oort 1992). Patterns of thermohaline (affected by salt and temperature) ocean circulation probably change during periods of glaciation (Lynch-Stieglitz et al. 1999). The nature of changes in patterns of thermohaline circulation appear to determine the duration and intensity of climate change (Ganopolski and Rahmstorf 2001). Although the climate of the GOA is not directly affected by thermohaline circulation, climate in the GOA is influenced by thermohaline circulation through climatic linkages to other parts of the globe.

Teleconnection between North Pacific and the Tropical Pacific can periodically strongly influence levels of coastal and interior precipitation. Because changing patterns in precipitation alter the expression of the ACC (Figure 3.5), which is largely driven by runoff (Royer 1981a), periodically changing weather patterns such as the Pacific Decadal Oscillation (PDO) and the El Niño Southern Oscillation (ENSO) can profoundly alter the circulation and biology of the GOA. (See Section 3.2.2.3.)

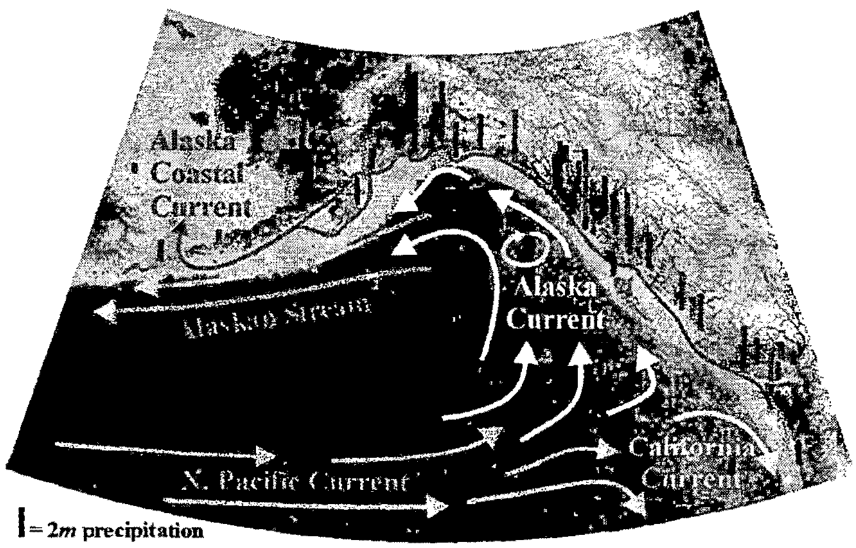


Figure 3.5 Schematic surface circulation fields in the GOA and mean annual precipitation totals from coastal stations (black vertical bars) and for the central GOA (Baumgartner and Reichel 1975).

The effects of the cool ACC and the warmer Alaska Stream moderate air temperatures. GOA ocean temperatures are important in determining climate in the fall and early winter in the northern GOA and may be influential at other times of the year. Because the cool glacially influenced waters of the ACC moderate air temperatures along the coast, the strength and stability of the ACC are important in determining climate.

3.2.3 Multi-decadal and Multi-annual Time Scales

3.2.3.1 Precession and Nutation

Short period changes in the seasonal and geographic distribution of solar radiation are also due to changes in the earth's orientation and rotational speed (day length) (Lambeck 1980). Wobbling (precession) and nodding (nutation) of the earth as it spins on its axis are primarily due to the fluid nature of the atmosphere and oceans, the gravitational attraction of sun and moon, and the irregular shape of the planet.

Small periodic variations in the length of the day occur with periods of 18.6 years, 1 year, and 60 other periodic components. The periodic components are due to both lunar and solar tidal forcing. In addition to its effect on day length, lunar tidal forcing with a period of 18.6 years has been associated with high-latitude climate forcing, periodic changes in intensity of transport of nutrients by tidal mixing, and periodic changes in fish recruitment (Royer 1993, Parker et al. 1995). Biological and physical effects of the lunar tidal cycle may extend beyond effects associated with tidal mixing. About one-third of the energy input to the sea by lunar forcing serves to mix deep-water masses with adjacent waters (Egbert and Ray 2000). Oscillations in the lunar energy input could contribute to oscillations in biological productivity through effects on the rate of transport of nutrients to surface waters. The lunar tidal cycle appears to be approximately synchronous with the PDO.

Contemporary climate in the GOA is defined by large-scale atmospheric and oceanic circulation on a global scale. Two periodic changes in ocean and atmospheric conditions are particularly useful for understanding change in the climate of the GOA, the PDO and the ENSO. Although weather patterns in the Arctic and north Atlantic are also correlated with weather in the North Pacific, these relations are far from clear. The PDO, ENSO, and other patterns of climate variability combine to give the GOA a variable and sometimes severe climate that serves as the incubator for the winter storms that sweep across the North American continent through the Aleutian storm track (Wilson and Overland 1986).

Increased understanding of the PDO has been made possible by simple yet highly descriptive indices of weather, such as the NPI. These indices are discussed below. Changes in the annual values of these indices led to the realization that weather conditions in the GOA sometimes change sharply from one set of average conditions to a different set during a period of only a few years. These rapid climatic and oceanographic regime shifts are associated with similarly rapid changes in the animals and plants of the region that are of vital interest to government, industry, and the general public.

3.2.3.2 Pacific Decadal Oscillation

The PDO and associated phenomena appear to be major sources of oceanographic and biological variability (Mantua et al. 1997). Associated with the PDO are three semi-permanent atmospheric pressure regions dominating climate in the northern GOA–the Siberian and East Pacific high-pressure systems and the Aleutian Low pressure system. These regions have variable, but characteristic, seasonal locations. A prominent feature of the PDO and the climate of the GOA is the Aleutian Low, for which average geographic location changes periodically during the winter. Wintertime location of the Aleutian Low affects ocean circulation patterns and sea-level pressure patterns. It is characteristic of two climatic regimes: a southwestern locus called a negative PDO regime (as in 1972) and a northeastern locus called a positive PDO (1977) (Figures 3.6 and 3.7). The location of the Aleutian Low in the winter appears to be synchronized with annual abundances and strength of recruitment of some fish species (Hollowed and Wooster 1992, Francis and Hare 1994). The Aleutian Low pressure system averages about 1,002 millibars (Favorite et al. 1976), is most intense in winter, and appears to cycle in its average position and intensity with about a 20- to 25-year period (Rogers 1981, Trenberth and Hurrel 1994).

The PDO is studied with multiple indices, including the anomalies of sea level pressure (as in the NPI, which is discussed below), anomalies of sea surface temperature, and wind stress (Mantua et al. 1997, Hare et al. 1999). The PDO changes, or oscillates, between positive (warm) and negative (cool) states (Figures 3.8 and 3.9). In decades of positive PDOs, below-normal sea surface temperatures occur in the central and western North Pacific and above normal temperatures occur in the GOA. An intense low pressure is centered over the Alaska Peninsula, resulting in the GOA being warm and windy with lots of precipitation. In decades of negative PDOs, the opposite sea surface temperature and pressure patterns occur.

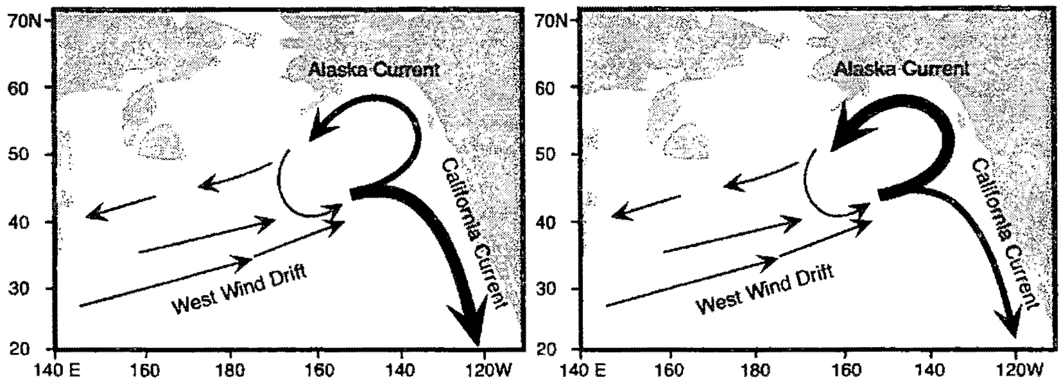


Figure 3.6 Oceanic circulation patterns in the far eastern Pacific Ocean proposed for negative PDO (left) and positive PDO (right). (Hollowed and Wooster 1992).

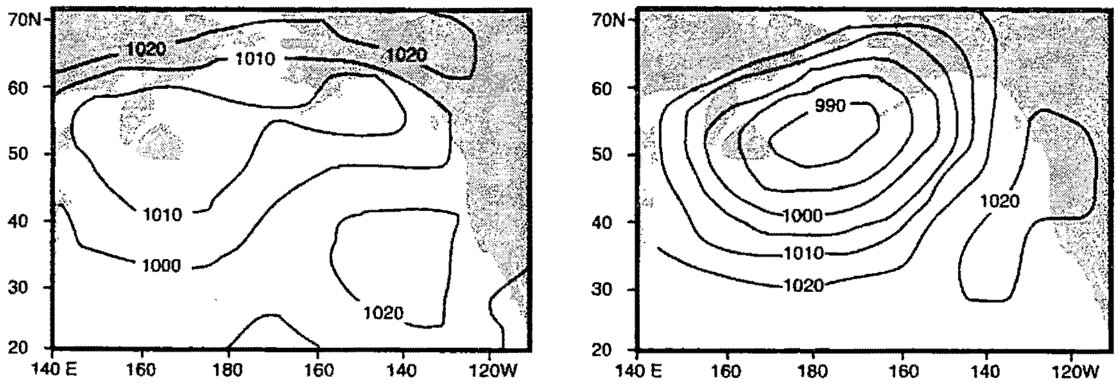
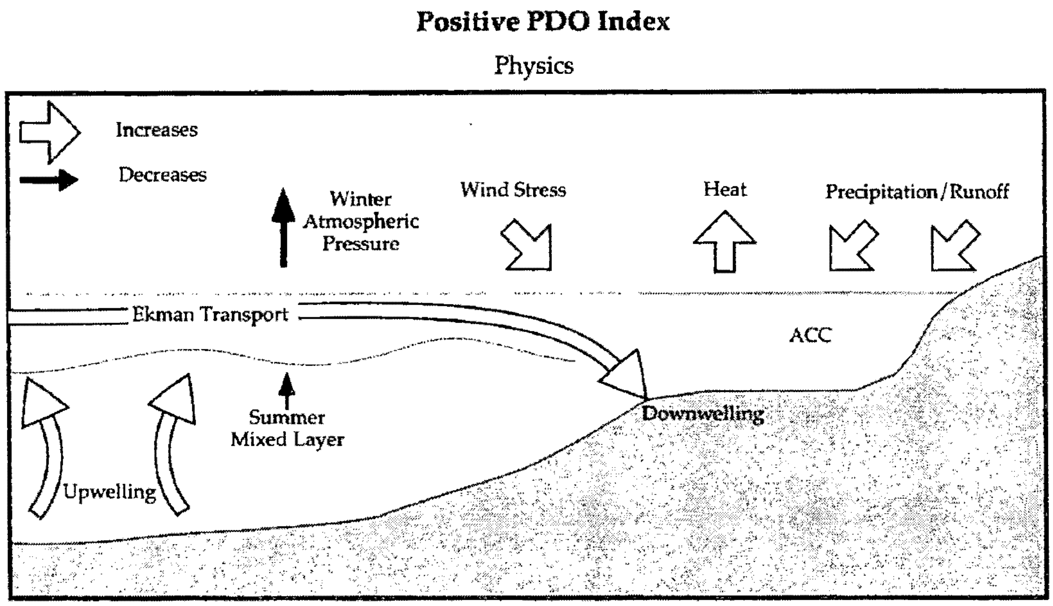


Figure 3.7 Mean sea-level pressure patterns from the winters of 1972 (left) and 1977 (right). (From Emery and Hamilton 1985).



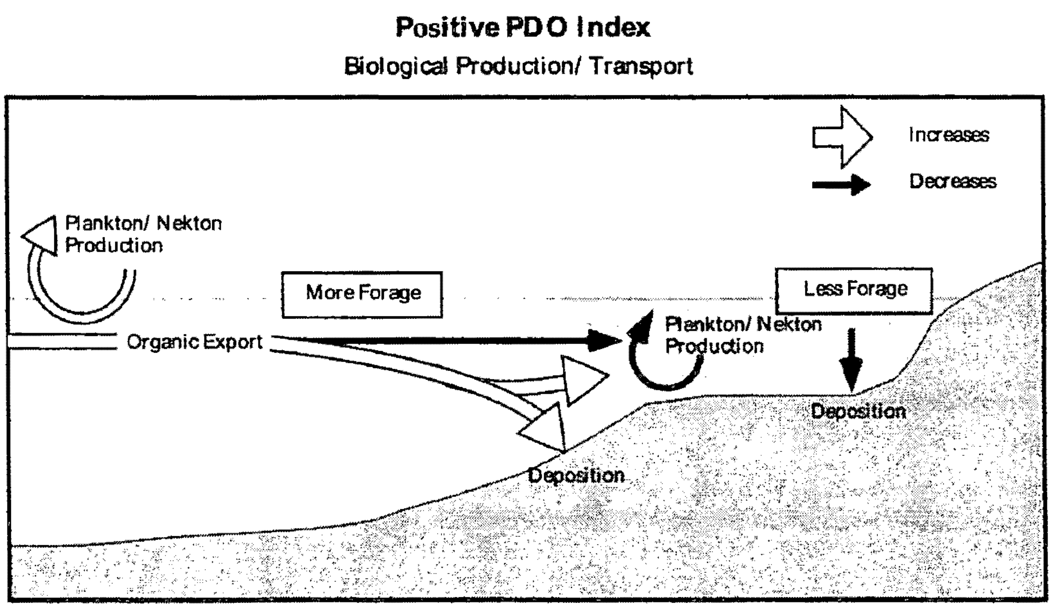
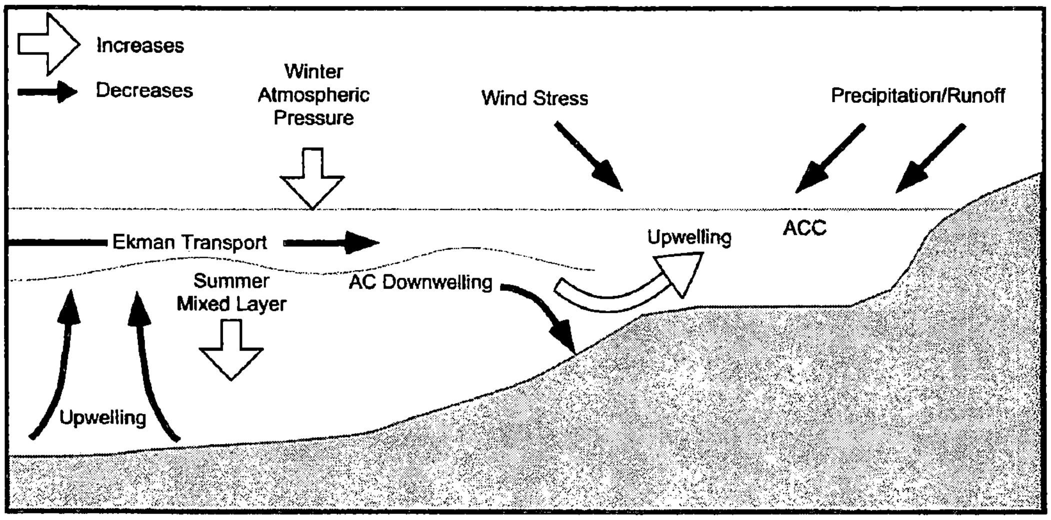


Figure 3.8 Schematic of physical processes during the winter in a positive PDO climatic regime in the Gulf of Alaska from offshore to nearshore areas showing the Alaska Current and the Alaska Coastal Current.

Negative PDO Index

Physics



Negative PDO Index

Biological Production/Transport

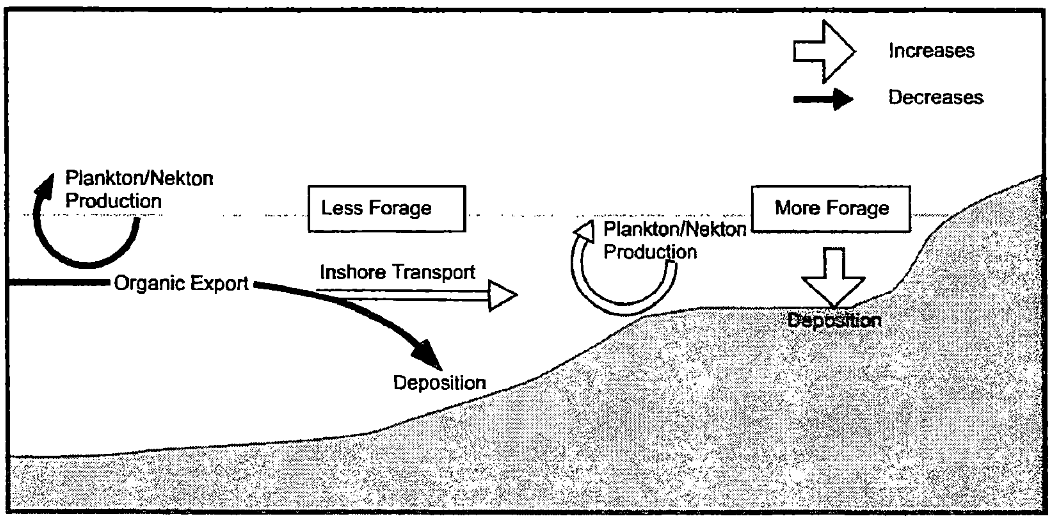


Figure 3.9 Schematic of physical processes during the winter in a negative PDO climatic regime in the Gulf of Alaska from offshore to nearshore areas showing the Alaska Current and the Alaska Coastal Current.

The NPI, a univariate time series representing the strength of the Aleutian Low, shows the same twentieth-century regimes defined by the PDO. The NPI is the anomaly, or deviation from the long-term average, of geographically averaged sea-level pressure in the region from 160° E to 140° W, 30° to 65° N, for the years 1899 to 1997 (Trenberth and Hurrel 1994, Trenberth and Paolino 1980). The NPI was used to identify climatic regimes in the twentieth century, for the years 1899 to 1924, 1925 to 1947, 1948 to 1976, and 1977 to 1997, and to explore the interactions of short (20-year) and long (50-year) period effects on the timing of regime shifts (Anderson and Munson 1972). Negative (cool) PDOs occurred during 1890 to 1924 and 1947 to 1976, and positive (warm) PDOs dominated from 1925 to 1946 and from 1977 to about 1995 (Mantua et al. 1997, Minobe 1997). Minobe's analysis of the NPI identified a characteristic S-shaped waveform with a 50-year period (sinusoidal pentadecadal) (Figure 4) (Anderson and Munson 1972). His analysis pointed out that rapid transitions from one regime to another could not be fully explained by a single sinusoidal-wavelike effect. The speed with which regime shifts occurred in the twentieth century led Minobe to suggest that the pentadecadal cycle is synchronized or phase locked with another climate variation on a shorter bidecadal time scale (Anderson and Munson 1972).

In addition to periodic and seasonal changes, there is evidence that the Aleutian storm track has shifted to an overall more southerly position during the twentieth century (Richardson 1936, Klein 1957, Whittaker and Horn 1982, Wilson and Overland 1986).

3.2.3.3 El Niño Southern OscillationThe ENSO is a weather pattern (Is ENSO really a weather pattern or an ocean/pressure pattern?) originating in the equatorial Pacific with strong influences as far north as the GOA (Emery and Hamilton 1985). ENSO is marked by three states: warm, normal, and cool (Enfield 1997). See Figure 3.10. Under normal conditions, the water temperatures at the continental boundary of the eastern Pacific are around 20° C, as cold bottom waters (8° C) mix with warmer surface water to form a large pool of relatively cool water of the coast of Peru. When an El Niño (warm) event starts, the pool of cool coastal water at the continental boundary becomes smaller and smaller as warm water masses (20° C to 30° C) from the west move on top of them, and the sea level starts to rise. At full El Niño, increases in the surface water temperatures of as much as 5.4° C have been observed very close to the coast of Peru. El Niño also brings a sea level rise along the Equator in the eastern Pacific Ocean of as much as 34 centimeters, as warm buoyant waters moving in from the west override cooler, denser water masses at the continental boundary. In a cool La Niña event, the sea levels are the opposite from an El Niño, and relatively cool (less than 20° C) waters extend well offshore along the equator. Note that the sea surface temperature changes associated with ENSO events extend well into the GOA (Figure 3.10).

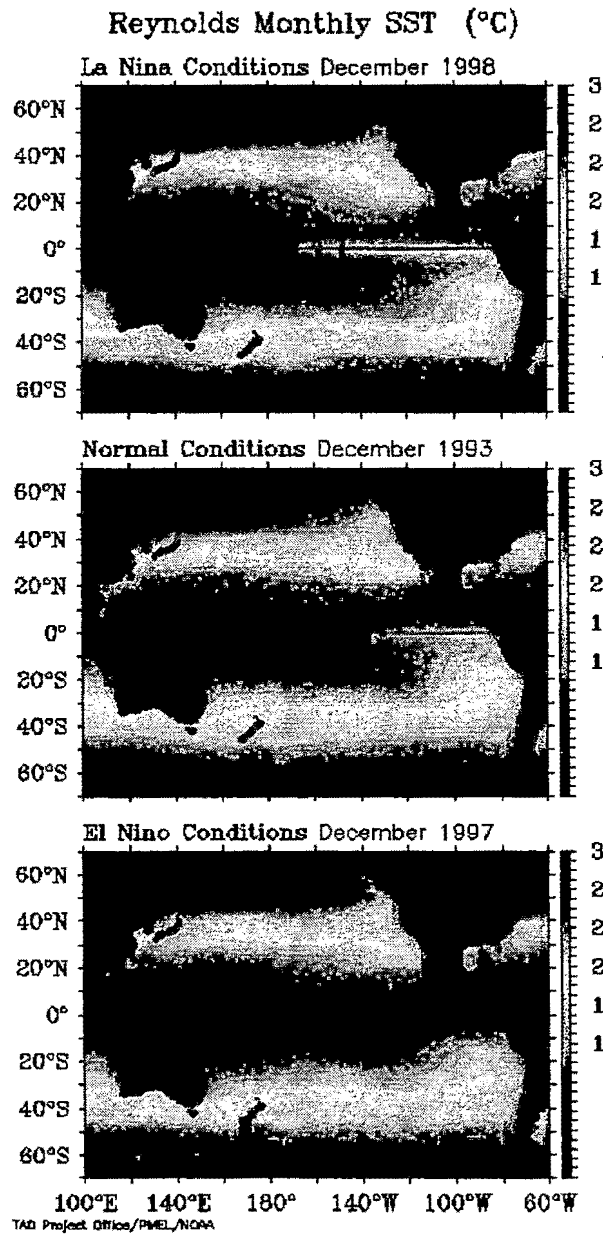


Figure 3.10 Pacific Ocean Reynolds monthly sea surface temperature (SST) in degrees Celsius during La Niña (top), El Niño bottom), and normal (middle) ENSO events. Source: Tropical Atmosphere Ocean Project Office, Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration, available at <http://www.pmel.noaa.gov/toga-tao/el-nino/la-nina-pacific.html>. also use Martin reference? (Martin 1997) http://www.pmel.noaa.gov/toga-tao/el-nino/la-nina-pacific.html

The ENSO has effects in some of the same geographic areas as PDO, but there are two major differences between these patterns. First, an ENSO event does not last as long as a PDO event, and second an ENSO event starts, and is easiest to detect, in the eastern equatorial Pacific, whereas PDO dominates the eastern North Pacific, including the GOA. The simultaneous occurrence of two major weather patterns in one location illustrates Minobe's point that multiple forcing factors with different characteristic frequencies must be operating simultaneously to create regime shifts (Figure 3.3).

3.3 Marine-Terrestrial Connections

The role of marine inputs to the watershed phase of regional biogeochemical cycles has been recognized for some time (Mathisen 1972). The following species have been found to transport marine nutrients within watersheds:

- Anadromous species, such as salmon (Kline et al. 1993, Ben-David et al. 1998a);
- Marine-feeding land animals, such as river otters (Ben-David et al. 1998b) and coastal mink (Ben-David et al. 1997a); and
- Opportunistic scavengers as riverine mink (Ben-David et al. 1997a), wolf (Szepanski et al. 1999), and martens (Ben-David et al. 1997b).

In theory, any terrestrial bird or mammal species that feeds in the marine environment, such as harlequin duck or black-tailed deer, is a pathway to the watersheds for marine nutrients. Species that transport marine nutrients play important roles in supporting a wide diversity of other fauna and flora, as determined from levels of marine nitrogen in juvenile fish, invertebrates, and aquatic and riparian plants (Bilby et al. 1996, Piorkowski 1995, Ben-David et al. 1998a, 1998b). In studies of a small Alaska stream containing chinook salmon, Piorkowski (1995) supported the hypothesis that salmon carcasses can be important in structuring aquatic food webs. In particular, microbial composition and diversity determine the ability of the stream ecosystem to use nutrients from salmon carcasses, a principal source of marine nitrogen.

The role of marine nutrients in watersheds is key to understanding the relative importance of climate and human-induced changes in population levels of birds, fish, and mammals. Indeed, losses of basic habitat productivity because of low numbers of salmon entering a watershed (Kline et al. 1993, Mathisen 1972, Piorkowski 1995, Finney et al. 2000) may be confused with the effects of fisheries interceptions or marine climate trends. Comparison of anadromous fish-bearing streams to non-anadromous streams has demonstrated differences in productivities related to marine nutrient cycling. Import of marine nutrients and food energy to the lotic (flowing water) ecosystem may be retarded in systems that have been denuded of salmon for any length of time (Piorkowski 1995).

Paleoecological studies (which focus on ancient events) in watersheds bearing anadromous species can shed light on long-term trends in marine productivity. Use of marine nitrogen in sediment cores from freshwater spawning and rearing areas to reconstruct prehistoric abundance of salmon offers some insights into long-term trends in climate, and into how to separate the effects of climate from human impacts such as fishing and habitat degradation (Finney 1998).

As agencies grapple with implementation of ecosystem-based management, conservation actions are likely to focus more on ecosystem processes and less on single species.

Watershed studies linking the freshwater and marine portions of the regional ecosystem could pay important benefits to natural resource management agencies. As agencies grapple with implementation of ecosystem-based management, conservation actions are likely to focus more on ecosystem processes and less on single species (Mangel et al. 1996). In the long-term, protection of Alaska's natural resources will require extending the protection now afforded to single species, such as targeted commercially important salmon stocks, to ecosystem functions (Mangel et al. 1996). In process-oriented conservation (Mangel et al. 1996), production of ecologically central vertebrate species is combined with measures of the production of other species and measures of energy and nutrient flow among trophic levels to identify and protect ecological processes such as nutrient transport. Applications of ecological process measures in Alaska ecosystems have shown the feasibility and potential importance of such measures (Kline et al. 1990, Kline et al. 1993, Mathisen 1972, Piorkowski 1995, Ben-David et al. 1997a, 1997b, 1998a, 1998b, Szepanski et al. 1999), as have applications outside of Alaska (Bilby et al. 1996, Larkin and Slaney 1997).

3.4 Physical and Geological Oceanography: Coastal Boundaries and Coastal and Ocean Circulation

3.4.1 Physical Setting, Geology, and Geography

The GOA includes the continental shelf, slope, and abyssal plain of the northern part (north of 50° N) of the northeastern Pacific Ocean. It extends 3,600 kilometers (km) westward from 127° 30′ W near the northern end of Vancouver Island, British Columbia, to 176° W along the southern edge of the central Aleutian Islands. It includes a continental shelf area of about 3.7×10^5 km^2 (110,000 square nautical miles [Lynde 1986]). The area of the shelf amounts to about 17% of the entire Alaskan continental shelf area (2.86×10^6 km^2 total) and approximately 12.5% of the total continental shelf of the United States (McRoy and Goering 1974). This vast oceanic domain sustains a rich and diverse marine life that supports the economic and subsistence livelihood for both Alaskans and people living in Asia and North America. The GOA is also an important transportation corridor for vessels carrying cargo to and from Alaska and vessels traveling the Great Circle Route between North America and Asia.

The high-latitude location and geological history of the GOA and adjacent landmass strongly influence present-day regional meteorology, oceanography, and sedimentary environment. The northern extension of the Cascade Range, with mountains ranging in altitude from 3 to 6 km, rings the coast from British Columbia to Southcentral Alaska (Royer 1982). The Aleutian Range spans the Alaska Peninsula in the western GOA and contains peaks exceeding 1000 m in elevation. All of the mountains are young and therefore provide plentiful sources of sediment to the ocean. The region is seismically active because it lies within the converging boundaries of the Pacific and North American plates. The motions of these plates control the seismicity, tectonics, volcanism, and much of the morphology of the GOA and make this region one of the most tectonically active regions on earth (Jacob 1986). Indeed, tectonic motion continuously reshapes the seafloor through faulting, subsidence, landslides, tsunamis, and soil liquefaction. For example, as much as 15 m of uplift occurred over portions of the shelf during the Great Alaska Earthquake of 1964 (Malloy and Merrill 1972, Plafker 1972, von Huene et al. 1972). These geological processes influence ocean circulation patterns, delivery of terrestrial sediments to the ocean, and reworking of seabed sediments.

Approximately 20% of the GOA watershed is covered by glaciers today (Royer 1982) making the region the third greatest glacial field on earth (Meier 1984). The glaciers reflect both the subpolar, maritime climate and the regional distribution of mountains, or orography, of the GOA (see Section 3.3) of the GOA. The climate setting includes high rates of precipitation and cool temperatures, especially at high altitudes, that enhance the formation of the icefields and glaciers. The icefields are both a source and sink for the fresh water delivered to the ocean. In some years the glaciers gain and store the precipitation as ice and snow; in other years, the stored precipitation is released into the numerous streams and rivers draining into the GOA. Glacial scouring of the underlying bedrock provides an abundance of fine-grained sediments to the GOA shelf and basin (Hampton et al. 1986). The major inputs of glacial sediment are the Bering and Malaspina glaciers and the Alsek and Copper rivers in the northern GOA and the Knik, Matanuska, and Susitna rivers that feed Cook Inlet in the northwest GOA (Hampton et al. 1986).

The bathymetry, or bottom depth variations, of the GOA reflects the diverse and complex geomorphological processes that have worked the region during millions of years. The GOA abyssal plain gradually shoals from a 5,000-m depth in the southwestern GOA to less than 3000 m in the northeastern GOA. Maximal depths exceed 7,000 m near the central Aleutian Trench along the continental slope south of the Aleutian Islands. Numerous seamounts, remnants of subsea volcanoes associated with spreading centers in the Pacific lithospheric plate (at the earth's crust), are scattered across the central basin. Several of the seamounts or guyots (flat-topped seamounts) rise to within a few hundred meters of the sea surface and provide important mesopelagic (middle depth of the open sea) habitat for pelagic (open sea) and benthic (bottom) marine organisms.

The continental shelf varies in width from about 5 km off the Queen Charlotte Islands in the eastern GOA to about 200 km north and south of Kodiak Island. Along the Aleutian Islands, the shelf break is extremely narrow or even absent, as depths plunge rapidly north and south of the island chain. The numerous passes between these islands control the flow between the GOA and the Bering Sea, with depths (and inflow) generally increasing in the westerly direction (Favorite 1974). In the eastern Aleutians, most of the passes are shallow and narrow, the largest being Amukta Pass with a maximal depth of 430 m and an area of about 20 km^2 (Favorite 1974). Unimak Pass is the easternmost pass (of oceanographic significance) and connects the southeast Bering Sea shelf directly to the GOA shelf near the Shumagin Islands. This pass is about 75 m deep and has a cross-sectional area of about 1 km^2 (Schumacher et al. 1982).

The shelf topography in the northern GOA is enormously complex because of both tectonic and glacial processes (Figure 3.11). Numerous troughs and canyons, many oriented across the shelf, punctuate the sea floor. Subsea embankments and ridges abound as a result of subsidence, uplift, and glacial moraines. These geological processes have also shaped the immensely complicated coastline that includes numerous silled and unsilled fjords, embayments, capes, and island groups.

The northwestern GOA includes several prominent geological features that influence the regional oceanography. Kayak Island, which extends about 50 km across the shelf east of the mouth of the Copper River, can deflect inner shelf waters offshore. Interaction of shelf currents with this island can also spawn eddies that transport nearshore waters, which have a high suspended sediment load, onto the outer shelf (Ahlnäes et al. 1987).

PWS, which lies west of Kayak Island, is a large complex, fjord-type estuarine system with characteristics of an inland sea (Muench and Heggie 1978). The sound communicates with the GOA shelf through Hinchinbrook Entrance in the eastern sound and Montague Strait and several smaller passes in the western sound. The shelf is relatively shallow (about 125 m deep) south of Hinchinbrook Entrance and along the eastern shore of Montague Strait. Hinchinbrook Canyon, however, has depths of about 200 m and extends southward from Hinchinbrook Entrance and opens onto the continental slope. This canyon is a potentially important conduit by which slope waters can communicate directly with sound. Central PWS is about 60 km by 90 km with depths typically in excess of 200 m and a maximal depth of about 750 m in the northern sound. The entrances to PWS are guarded by the shelf, sills, or both of about 180-m depth. Numerous islands are scattered throughout the sound and bays, fjords, and numerous glaciers are interspersed along its rugged coastline.

FIGURE 3.11

(Figure 1, from (Hampton et al. 1986) p. 97)

Several silled fjords indent the northern GOA coast, between PWS and Cook Inlet. Inner fjord depths can exceed 250 m, which are greater than the depths over the adjacent shelf. To the west of the Kenai Peninsula is Cook Inlet, which extends about 275 km from its mouth to Anchorage at its head. The inlet is about 90 km wide at its mouth, narrows to about 20 km at the Forelands some 200 km from the mouth, and then widens to about 30 km near Anchorage. Upper Cook Inlet branches into two narrow arms (Turnagain and Knik) that extend inland another 70 km. Depths range from 100 m to 150 m at the mouth of Cook Inlet to less than 40 m in the upper end, with the upper arms being so shallow that extensive mudflats are exposed during low tides. The bottom topography throughout the inlet reflects extensive faulting and glacial erosion (Hampton et al. 1986).

At its mouth, Cook Inlet communicates with the northern shelf through Kennedy Entrance, to the east, and with Shelikof Strait, to the west. The latter is a 200-km by 50-km rectangular channel between Kodiak Island and the Alaska Peninsula with numerous fjords indenting the coast along both sides of the strait. The main channel, with depths between 150 and 300 m, veers southeastward at the lower end of Kodiak Island and intersects the continental slope west of Chirikof Island. Southwest of Shelikof Strait bottom depths shoal to 100 to 150 m, and the shelf is complicated by the passes and channels associated with the Shumagin and Semidi islands.

3.4.2 Atmospheric Forcing of GOA Waters

The climate over the GOA is largely shaped by three semi-permanent atmospheric pressure patterns: the Aleutian Low, the Siberian High, and the East Pacific High (Wilson and Overland 1986). These systems represent statistical composites of many individual pressure cells moving across the northern North Pacific. The climatological position of these pressure systems varies seasonally, as shown in Figure 3.12. From October through April, the cold air masses of the Siberian High deepen over northeastern Siberia, and the East Pacific High is centered off the southwest coast of California. From May through September, the Siberian High weakens and the East Pacific High migrates northward to about 40° N and attains its greatest intensity (highest pressure) in June. The seasonal changes in intensity and position of these high-pressure systems influence the strength and propagation paths of low-pressure systems (cyclones) over the North Pacific. In winter, the Siberian High forces storms into the GOA, and lows are strong; in summer, these systems are weaker and propagate along a more northerly track across the Bering Sea and into the Arctic Ocean.

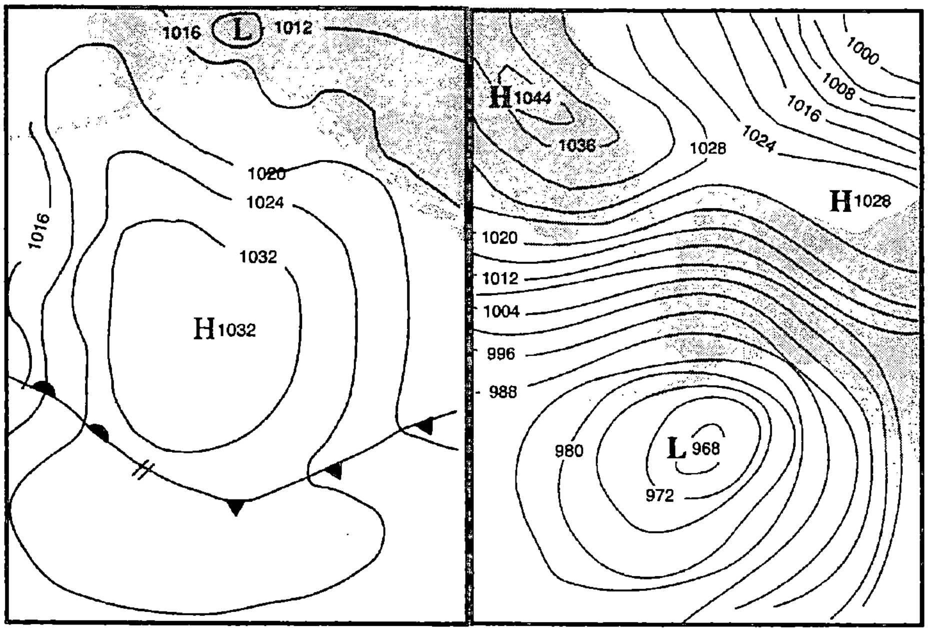


Figure 3.12 Typical summer (left) and winter (right) examples of the Aleutian Low and Siberian High pressure systems. Contours are sea-level pressure in millibars. (From Carter). need reference

The low-pressure storm systems that compose the Aleutian Low form in three ways. Many are generated in the western Pacific when cold, dry air flows off Asia and encounters northward-flowing, warm ocean waters along the Asian continent. Additional formation regions occur in the central Pacific along the Subarctic Front (near 35° N) where strong latitudinal gradients of ocean temperature interact with unstable, winter air masses (Roden 1970). Finally, the GOA can also be a region of active cyclogenesis (low-pressure formation), particularly in winter when frigid air spills southward over the frozen Bering Sea, the Alaska mainland, or both (Winston 1955). Such conditions can be hazardous to mariners because the accompanying high wind speeds and subfreezing air temperatures can lead to rapid vessel icing (Overland 1990).

Regardless of origin, these lows generally strengthen as they track eastward across the North Pacific. This intensification results from the flux of heat and moisture from the ocean to the atmosphere. The lows attain maximal strength (lowest pressure) in the western and central GOA. Once in the GOA, the coastal mountains inhibit inland propagation, so that the storms often stall and dissipate here. Indeed, Russian mariners refer to the northeastern GOA as the "graveyard of lows" (Plakhotnik 1964).

The mountains also force air masses upward, resulting in cooling, condensation, and enhanced precipitation. The precipitation feeds numerous mountain drainages that feed the GOA or, in winter, is stored in snowfields and glaciers where it can remain for periods ranging from months to years.

Seasonal variations in the intensity and paths of these low-pressure systems markedly influence meteorological conditions in the GOA. Of particular importance to the marine ecosystem are the seasonal changes in radiation, wind velocity, precipitation, and coastal runoff.

Seasonal variations in the intensity and paths of low-pressure systems influence meteorological conditions in the GOA.

The incoming short-wave radiation that warms the sea surface and provides the energy for marine photosynthesis is strongly affected by cloud cover. Throughout the year, cloud cover of more than 75% occurs over the northern GOA more than 60% of the time (Brower et al. 1988), and cloud cover of less than 25% occurs less than 15% of the time. Interannual variability in cloud cover, especially in summer, can affect sea-surface temperatures and possibly the mixed-layer structure (which also depends heavily on salinity distribution). The anomalously warm surface waters observed in the summer and fall of 1997 were probably due to unusually low cloud cover and mild winds (Hunt et al. 1999). The characteristic cloud cover is so heavy that it hinders the effective use of passive microwave sensors, such as Advanced Very High Resolution Radar (AVHRR) and Sea-viewing Wide Field of view Sensor (SeaWifs), in ecosystem monitoring.

The cyclonic (counterclockwise) winds associated with the low-pressure systems force an onshore surface transport (Ekman transport) over the shelf and downwelling along the coast. Figure 3.13 shows the mean monthly Upwelling Index on the northern GOA shelf. This index is negative (implying downwelling) in most months, indicating the prevalence of onshore Ekman transport and coastal convergence. Downwelling favorable winds are strongest from November through March, and feeble or even weakly anticyclonic (upwelling favorable) in summer when the Aleutian Low is displaced by the East Pacific High (Royer 1975, Wilson and Overland 1986). Over the central basin, these winds exert a cyclonic torque (or wind-stress curl) that forces the large-scale ocean circulation.

The high rates of precipitation are evident in long-term average measurements. Figure 3.5 is a composite of long-term average annual precipitation measurements from stations around the GOA. Precipitation rates of 2 to 4 meters per year ($m\text{-}yr^{-1}$) are typical throughout the region, but rates in southeast Alaska and PWS exceed 4 $m\text{-}yr^{-1}$. Except over the Alaska Peninsula in the western GOA, the coastal precipitation rates are much greater than the estimated net precipitation rate of 1 $m\text{-}yr^{-1}$ over the central basin (Baumgartner and Reichel 1975). The coastal estimates are undoubtedly biased because most of the measurements are made at sea level and therefore do not fully capture the influence of altitude on the precipitative flux.

Figure 3.13 also includes the mean monthly coastal discharge from Southeast and Southcentral Alaska as estimated by Royer (1982). On an annual average this freshwater influx is enormous and amounts to about 23,000 $m^3\ s^{-1}$, or about 20% greater than the mean annual Mississippi River discharge, and accounts for nearly 40% of the freshwater flux into the GOA. This runoff enters the shelf mainly through many small (and ungauged) drainage systems, rather than from a few major rivers. Consequently, the discharge can be thought of as a diffuse, coastal "line" source" around the GOA perimeter, rather than arising from a few, large "point" sources. The discharge is greatest in early fall and decreases rapidly through winter, when precipitation is stored as snow. There is a secondary runoff peak in spring and summer, because of snowmelt (Royer 1982). The phasing and magnitude of this freshwater flux is important, because salinity primarily affects water densities (and therefore ocean dynamics) in the northern GOA.

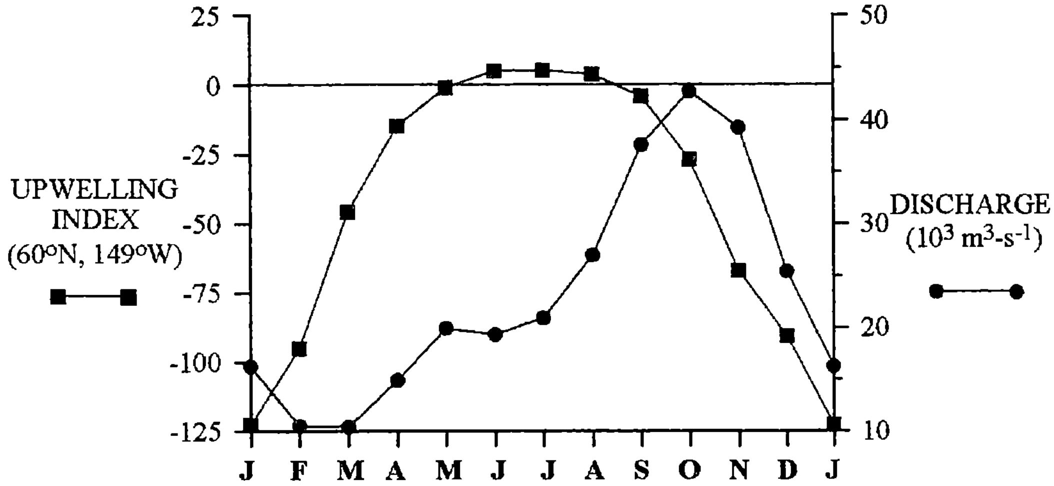


Figure 3.13 Mean monthly Upwelling Index, 1946 to 1999 (red), and mean monthly coastal discharge, 1930 to 1999 (blue) (Royer 1982, 2000) in the northern GOA. Negative values of the Index imply onshore Ekman transport and coastal downwelling. Discharge is shown in cubic meters per second, a measure of flow.

Figure 3.13 shows that the seasonal variation in wind stress and freshwater discharge is large, but also that these variables are not in-phase with one another; downwelling is maximal in winter and minimal in summer, whereas discharge is maximal in fall and minimal in late winter. Both winds and buoyant discharge affect the vertical density stratification and contribute to the formation of horizontal pressure (and density) gradients over the shelf and slope. The wind field over the shelf is spatially coherent (Livingstone and Royer 1980) because the scale of the storm systems that enter the GOA are comparable to the size of the basin. The alongshore coherence of the wind field and the distributed nature of the coastal discharge suggest that forcing by winds and buoyancy is approximately uniform along the length of the shelf. Both the winds and buoyant flux force the mean cyclonic alongshore flow over the GOA shelf and slope (Reed and Schumacher 1986, Royer 1998), as shown schematically in Figure 3.3. On the inner shelf, the flow consists of the ACC, and over the slope, it consists of the Alaska Current (eastern and northeastern GOA) and the Alaskan Stream (northwestern GOA). These current systems are extensive, swift, and continuous over a vast alongshore extent. Thus, the shelf and slope are strongly affected by advection (transport of momentum, energy, and dissolve and suspended materials by ocean currents), implying that climate perturbations, even those occurring far from the GEM study area, can be efficiently communicated into the northwestern GOA by the ocean circulation. The strong advection also implies that processes occurring far upstream might substantially influence biological production within the GEM area.

3.4.3 Physical Oceanography of the Gulf of Alaska Shelf and Shelf Slope

The GOA shelf can be divided on the basis of water-mass structure and circulation characteristics into three domains:

- The inner shelf (or ACC domain) consisting of the ACC;
- The outer shelf, including the shelf-break front; and
- The mid-shelf region between the inner and outer shelves.

Because the boundaries separating these regions are dynamic, their locations vary in space and time. Although dynamic connections among these domains undoubtedly exist, the nature of these links is poorly understood.

The ACC is the most prominent aspect of the shelf circulation. It is a persistent circulation feature that flows cyclonically (westward in the northern GOA) throughout the year. This current originates on the British Columbian shelf (although in some months or years, it might originate as far south as the Columbia River [Royer 1998, Thomson et al. 1989]), about 2,500 km from its entrance into the Bering Sea through Unimak Pass, in the western GOA (Schumacher et al. 1982).

The ACC is a swift (20 to 180 centimeters per second [cm s^{-1}] [0.4 to 3.6 knots]), coastally trapped flow typically found within 35 km of the shore (Royer 1981b, Johnson et al. 1988, Stabeno et al. 1995). Much or all of the ACC loops through southern PWS, entering through Hinchinbrook Entrance and exiting through Montague Strait (Niebauer et al. 1994). Therefore, the ACC potentially is important to the circulation dynamics of PWS; clearly, it is a critical advective and migratory path for material and organisms between the GOA and sound. West of PWS, the ACC branches northeast of Kodiak Island. The bulk of the current curves around the mouth of Cook Inlet and continues southward through Shelikof Strait (Muench et al. 1978); the remainder flows southward along the shelf east of Kodiak Island (Stabeno et al. 1995). Although there are no long-term (multiyear) estimates of transport in the ACC, direct measurements (Schumacher et al. 1990, Stabeno et al. 1995) along the Kenai Peninsula and upstream of Kodiak suggest an average transport of about 0.8 Sverdrup (Sv, a unit of flow equal to 1 million cubic meters per second [1 Sv equals 10^6 m^3 s^{-1}]), with a maximum in winter and a minimum in summer.

The large annual cycle in wind and freshwater discharge is reflected in the mean monthly temperatures and salinities at hydrographic station GAK 1, near Seward, on the inner shelf (Figure 3.14). Mean monthly sea-surface temperatures range from about 3.5° C in March to about 14° C in August. The amplitude of the annual temperature cycle, however, diminishes with depth, with the annual range being only about 1° C at depths greater than 150 m. Surface temperatures are colder than subsurface temperatures from November through May, and the water column has little thermal stratification from December through May.

Surface salinities range from a maximum of about 31 practical salinity units (psu) in late winter to a minimum of 25 psu in August. Vertical salinity (density) gradients are minimal in March and April and maximal in the summer months. Surface stratification commences in April or May (somewhat earlier in PWS), as cyclonic wind stress decreases and runoff increases, and is greatest in mid- to late summer. The inner shelf and PWS stratify first, because runoff initially is confined to nearshore regions and only gradually spreads offshore through ocean processes. Solar heating provides additional surface buoyancy by warming the upper layers uniformly across the shelf. However, the thermal stratification remains weak until late May or June. As winds intensify in fall, the stratification erodes, resulting from stronger vertical mixing and increased downwelling, which causes surface waters to sink along the coast.

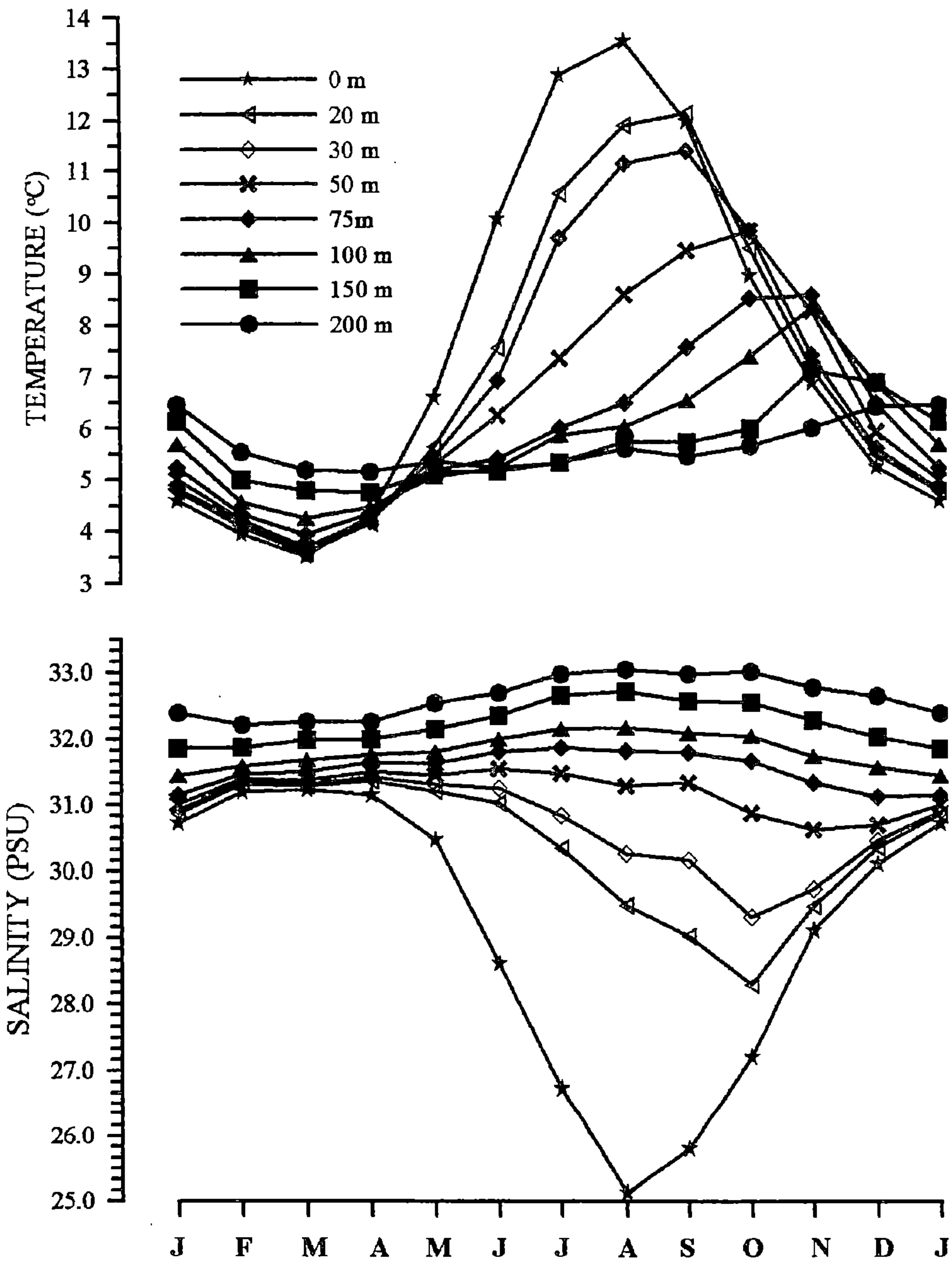


Figure 3.14 The mean annual cycle of temperature (upper) and salinity (lower) at various depths at station GAK 1 on the inner shelf of the northern GOA. The monthly estimates are based on data collected from 1970 through 1999. (The figure includes updated information [Xiong and Royer 1984].)

Within the ACC, the annual amplitude in salinity diminishes with depth and has a minimum of about 0.5 psu at about the 100-m depth. At greater depths, the annual amplitude increases but the annual salinity cycle is out of phase with near-surface salinity changes. For example, at and below the 1,50 m depth, the salinity is minimal in March and maximal in late summer-early fall. The phase difference between the near-surface and near-bottom layers reflects the combined influence of winds and coastal discharge. In summer, when downwelling relaxes, salty, nutrient-rich water from offshore invades the inner shelf (Royer 1975). The upper portion of the water column is freshest in summer, when the winds are weak (little mixing) and coastal discharge is increasing. Vertical mixing is strong through the winter and redistributes fresh water, salt, and possibly nutrients throughout the water column.

The effects of the seasonal cycle of wind- and buoyancy forcing are also reflected in both the hydrographic properties and the along-shore velocity structure of the shelf. The seasonal transitions in temperature and salinity properties are shown in Figure 3.15, which is constructed from cross-shore sections along the Seward Line in the northern GOA for April (representative of late winter), August (summer), and October (fall).

The ACC domain, or inner shelf, is within 50 km of the coast. From February through April, the vertical and cross-shelf gradients of salinity and temperature are weak, and the ACC front lies within about 10 km of the coast and extends from the surface to the bottom. Vertical shears (gradients) of the along-shelf velocity are weak and the current dynamics are primarily wind-driven and barotropic (controlled by sea-surface slopes setup by the winds) at this time (Johnson et al. 1988, Stabeno et al. 1995). In summer (late May to early September), the vertical stratification is large, but cross-shelf salinity (and density) gradients are weak. The ACC front extends from 30 to 50 km offshore and usually no deeper than 40 m. The along-shelf flow is weak, although highly variable, in summer. Vertical stratification weakens in fall, but the cross-shelf salinity gradients and the ACC front are stronger than at other times of the year. As coastal downwelling increases, the front moves shoreward to within 30 km of the coast and steepens so that the base of the front intersects the bottom between the 50 and 100 m isobaths.

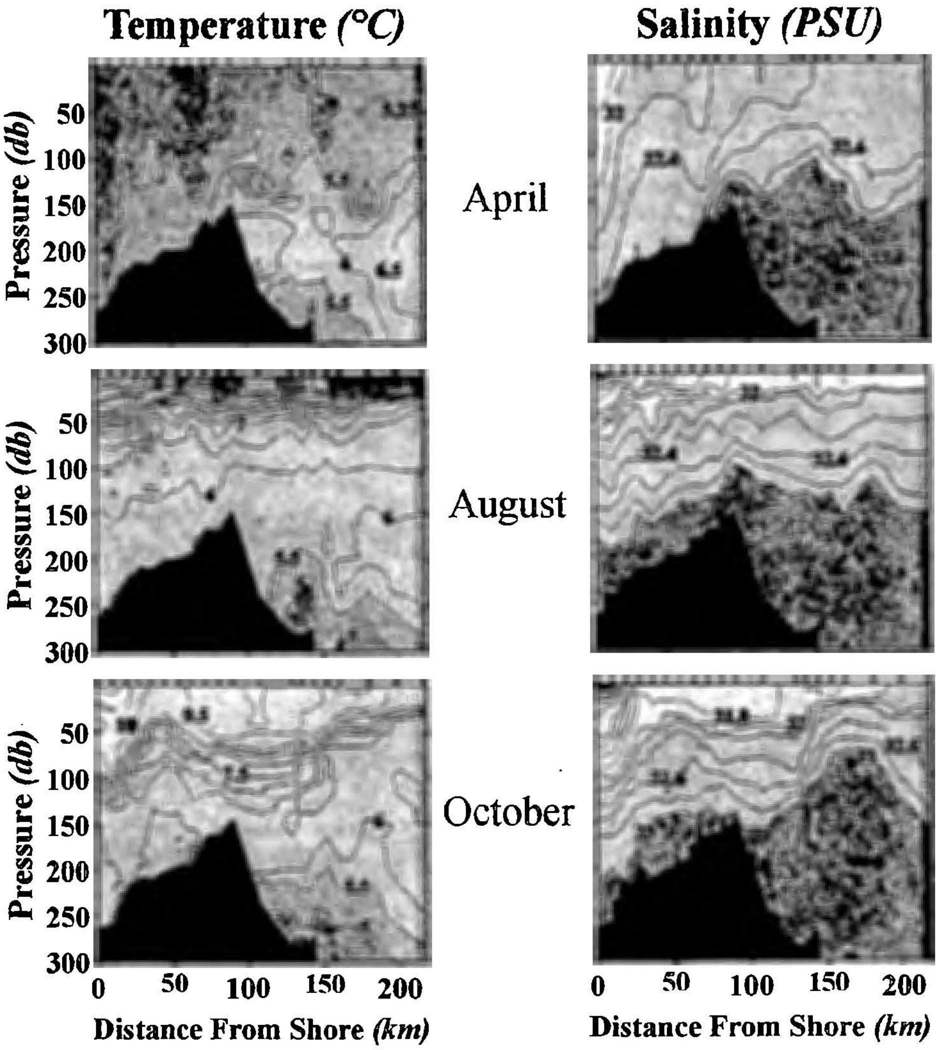


Figure 3.15 Seasonal cross-shore distributions of temperature (left) and salinity (right) along the Seward Line in the northern GOA. The graphs are based on data collected in 1999 as part of the GOA GLOBEC program (Weingartner 2001). The vertical axis is in pressure units (decibars [db]), with 1 db the equivalent of about 1 m.

Theory (Garrett and Loder 1981, Yankovsky and Chapman 1997, Chapman and Lentz 1994, Chapman 2000) suggests that seasonal variations in the ACC frontal structure should strongly influence the vertical and horizontal transport and mixing of dissolved and suspended material, both across and along the inner shelf. Royer et al. (1979) showed that surface drifters released seaward of the ACC front first drifted onshore (in accordance with Ekman dynamics) and then drifted along-shore upon encountering the ACC front. Conversely, Johnson et al. (1988) showed that, inshore of the front, the surface layer spreads offshore, with this offshore flow increasing as discharge increases in fall. Taken together, these results suggest cross-frontal convergence arising from differing dynamics on either side of the ACC front. Buoyancy effects dominate at the surface inshore of the front (at least for part of the year); wind forcing dominates offshore of the front. Convergence across the front would tend to accumulate plankton along the frontal boundary, possibly attracting foraging fish, seabirds, and marine mammals (Haldorson 2001). The front might also be a region of significant vertical motions. Downwelling velocities of about 30 meters per day ($m\text{-}d^{-1}$) in the upper 30 m of the water column are possible in fall. (This estimate is based on the assumption that the cross-frontal convergence occurs over a frontal width of 15 km with an onshore Ekman flow of 3 $cm\text{-}s^{-1}$ seaward of the front and an offshore flow of ~15 $cm\text{-}s^{-1}$ [Johnson et al. 1988] inshore of the front.)

The mid-shelf domain covers the region between 50 and 125 km from the coast. Here cross-shelf temperature and salinity gradients are weak in all seasons. In general, the strongest horizontal density gradients occur within the bottom 50 m of the water column, probably associated with the inshore location of the shelf-break front (which does not always have a surface expression). The bottom of the shelf-break front is generally found farther inshore in summer than in fall or winter. Over the upper portion of the mid-shelf water column, the vertical stratification is largely controlled by salinity in most months, although vertical salinity gradients are weaker here in summer and fall than on the inner shelf. Consequently, in summer, thermal stratification plays an important role in stratifying the mid-shelf water column. Here, the along-shelf flow is weakly westward on average because of the feeble horizontal density gradients. Both the flow and horizontal density gradients are highly variable, however, because of energetic mesoscale (10- to 50-km) flow features. Potential sources for the mesoscale variability are as follows:

1. Separation of the ACC from capes (Ahlnäes et al. 1987);
2. Instabilities of the ACC (Mysak et al. 1981, Bograd et al. 1994);
3. Interactions of the shelf flow with topography (Lagerloef 1983); and
4. Meandering of the Alaska Current along the continental slope (Niebauer et al. 1981).

This mesoscale variability is very difficult to quantify, because it depends on spatial variations in the coastline and the bottom topography and on seasonal variations in the winds and shelf density structure. Nevertheless, these mesoscale features appear to be biologically significant. For example, Incze et al. (1989), Vastano et al. (1992), Schumacher and Kendall (1991), Schumacher et al. (1993), and Bograd et al. (1994) show the coincidence between larval pollock numbers and the presence of eddies in Shelikof Strait. Moreover, the nutritional condition of first-feeding larvae is significantly better inside than outside of eddies (Canino et al. 1991).

The inner and mid-shelf domains share two other noteworthy characteristics. First, during much of the year, the cross-shelf sea surface temperature contrasts are generally small (about 2°C). The small thermal gradients and heavy cloud cover reduce the utility of thermal infrared radiometry in assessing circulation features and frontal boundaries in the northern GOA.

Second, the bottom-water properties of the shelf change markedly throughout the year. The above figures show that the high-salinity bottom waters carried inshore are drawn from over the continental slope in summer. This inflow occurs annually and probably exerts an important dynamical influence on the shelf circulation by modifying the bottom boundary layer (Gawarkiewicz and Chapman 1992, Chapman 2000, Pickart 2000). It might also serve as an important seasonal onshore pathway for oceanic zooplankton. These animals migrate diurnally over the full depth of the water column; during the long summer day length, the zooplankton will spend more time at the bottom than at the surface. The bottom flow that transports the high-salinity water shoreward might then result in a net shoreward flux of zooplankton in summer. The summertime inflow of saline water onto the inner shelf is one means by which the slope and basin interior communicates directly with the nearshore, because (as discussed below) this water is drawn from within the permanent halocline (depth horizon over which salinity changes rapidly) of the GOA. The deep summer inflow is a potentially important conduit for nutrients from offshore to onshore. Inflow, however, is not the only means by which nutrient-rich offshore water can supply the shelf. Other mechanisms include flow-up canyons intersecting the shelf break (Klinck 1996, Allen 1996, Allen 2000, Hickey 1997), topographically-induced upwelling (Freeland and Denman 1982), and shelf-break eddies and flow meanders (Bower 1991).

The third domain, consisting of the shelf break and continental slope is influenced by the Alaska Current, which flows along the northeastern and northern GOA, and its transformation west of 150° W, into the southwestward-flowing Alaskan Stream. These currents comprise the poleward limb of the North Pacific Subarctic Gyre and provide the oceanic connection between the GOA shelf and the Pacific Ocean. The Alaska Current is a broad (300 km), sluggish (5 to 15 cm s^{-1}) flow with weak horizontal and vertical velocity shears. The Alaskan Stream is a narrow (100 km), swift (100 cm s^{-1}) flow with large velocity shear over the upper 500 m (Reed and Schumacher 1986). The stream continues westward along the southern flank of the Alaska Peninsula and Aleutian Islands and gradually weakens west of 180° W (Thomson 1972). The convergence of the Alaska Current into the Alaskan Stream probably entails concomitant changes in the velocity and thermohaline gradients along the shelf break. Insofar as these gradients influence fluxes between the shelf and slope (Gawarkiewicz 1991), the transformation of the Alaska Current into the Alaskan Stream implies that shelf-break exchange mechanisms are not uniform around the GOA. Moreover, the effects of these exchanges on the shelf will also be influenced by the shelf width, which varies from 50 km or less in the eastern and northeastern GOA to about 200 km in the northern and northwestern GOA.

The Alaskan Stream has a mean annual volume transport (flow of water) of between 15 and 20 Sv (Reed and Schumacher 1986, Musgrave et al. 1992), and although seasonal transport variations appear small, interannual transport variations may be as great as 30% (Royer 1981a). Thomson et al. (1990) found that the Alaska Current is swifter and narrower in winter than in summer. Surface salinities within the Alaska Current vary by only about 0.5 psu throughout the year, whereas the seasonal change in sea surface temperature (SST) is comparable to that of the shelf (about 10° C). Nevertheless, horizontal and vertical density gradients are controlled by the salinity distribution. Maximal stratification occurs between depths of 100 and 300 m and is associated with the permanent halocline of the GOA. Halocline salinities range between 33 and 34 psu, and temperatures are between 5° C and 6° C (Tully and Barber 1960, Dodimead et al. 1963, Reid Jr. 1965, Favorite et al. 1976, Musgrave et al. 1992). These water-mass characteristics are identical to the properties of the deep water that floods the shelf bottom each summer (Figure 3.15.)

Although eddy energies of the Alaskan Stream appear small (Royer 1981a, Reed and Schumacher 1986), significant alteration of the slope and shelf-break circulation is likely during occasional passage of large (200-km-diameter) eddies that populate the interior basin (Crawford et al. 1999). Musgrave et al. (1992) show considerable alteration in the structure of the shelf-break front off Kodiak Island during the passage of one such eddy. These eddies are long-lived (2 to 3 years) and energetic, having typical swirl speeds of 20 to 50 cm s^{-1} (Tabata 1982, Musgrave et al. 1992, Okkonen 1992, Crawford et al. 1999). They form in the eastern GOA, primarily in years of anomalously strong cyclonic wind forcing along the eastern boundary (Willmott and Mysak 1980, Melsom. A. et al. 1999, Meyers and Basu 1999) and then propagate westward at about 2 to 3 cm s^{-1}. Most of the eddies remain over the deep basin and far from the continental slope; however, some propagate along the slope, requiring several months to transit from Yakutat to Kodiak Island (Crawford et al. 1999, Okkonen 2001).

Eddies that impinge upon the continental slope could significantly influence the shelf circulation and exchanges between the shelf and slope of salt, heat, nutrients, and plankton. Their influence on shelf-slope exchange in the northern GOA has not been ascertained, but because they propagate slowly, are long-lived, and form episodically, they could be a source of interannual variability for this shelf. These eddies have many features in common with the Gulf Stream rings that significantly modify shelf properties along the East Coast of the United States (Houghton et al. 1986, Ramp 1986, Joyce et al. 1992, Wang 1992, Schlitz submitted). In the eastern GOA, Whitney et al. (1998) showed that these eddies cause a net offshelf nutrient flux. In the northern GOA, they might have the opposite effect, because nutrient concentrations are generally higher over the slope than on the shelf (Whitledge 2000, Childers 2000).

3.4.4 Biophysical Implications

The magnitude of the spring phytoplankton bloom depends on surface nutrient concentrations and water-column stability. The annual resupply of nutrients to the euphotic zone is not understood for the inner shelf, however. Cross-shelf, surface Ekman transport in winter cannot account for the high nutrient concentrations observed on the inner shelf in spring (Childers 2000) and (Whitledge 2000). Turbulent mixing during late fall and winter could mix the nutrient-rich deep water (brought onto the shelf in summer) up into the surface layer in time for the spring bloom. If so, vernal nutrient levels might result from a two-stage preconditioning process occurring during the several months preceding the spring bloom. The first stage occurs in summer and is related to the onshelf movement of saline, nutrient-rich, bottom water as described above. The quantity of nutrients carried onshore then depends upon the summer wind field and the properties of the slope source water that contributes to this inflow. The second step occurs in fall and winter and depends on turbulence. Current instabilities, downwelling-induced convection, and diffusion accomplish the vertical mixing. The extent of this mixing depends upon the seasonally varying stratification and the vertical and horizontal velocity structure of the ACC. Each of these mechanisms probably varies from year to year, suggesting that spring nutrient concentrations will also vary.

Another potentially important nutrient source for the inner shelf in spring is PWS. Winter mixing in the sound could bring nutrient-rich water to the surface, where it is exported to the shelf by that portion of the ACC that loops through PWS.

The timing of the spring bloom depends on development of stratification within the euphotic zone. The euphotic zone extends from the surface to a depth where sufficient light still exists to support photosynthesis. Stratification within the euphotic zone is influenced by freshwater discharge and solar heating. Preliminary GLOBEC data (Whitledge 2000) (Stockwell 2000) suggest that the spring bloom begins in protected regions of PWS in late March as day length increases and stratification builds as a result of snowmelt, rainfall, and the sheltering effect of the PWS from winds. The bloom on the shelf lags that of PWS by from 2 to 6 weeks and may not proceed simultaneously across the shelf. This delay results from the time required to stratify the shelf. Because density is strongly affected by salinity and, therefore, by the spreading of fresh water on the shelf, stratification does not evolve by vertical (one-dimensional) processes phase-locked to the annual solar cycle. Rather, stratification depends primarily on the rate at which fresh water spreads offshore, which is a consequence of three-dimensional circulation and mixing processes intimately associated with ocean dynamics.

Several implications follow from this hypothesis. First, spring bloom dynamics on the shelf are not as tightly coupled to the solar cycle as on mid-latitude shelves where temperature controls density. Second, mixed-layer development depends on processes operating spanning a range of time scales and involves a plethora of variables that affect vertical mixing and the offshore flux of fresh water from the nearshore. These variables include the fractions of winter precipitation delivered to the coast as snow and rain, the timing and rate of spring snowmelt (a function of air temperature and cloudiness), and the wind velocity. The relevant time scales range from a few days (storm events) to seasonal or longer. The long time scales follow from the fact that the shelf circulation, particularly the ACC, can advect the freshwater that contributes to stratification from very distant regions. Third, interannual variability in the onset and strength of stratification on the GOA continental shelf is probably greater than for mid-latitude shelves. This expectation follows from the fact that several potentially interacting parameters affect stratification, and each or all can vary considerably from year to year. Therefore, application of Gargett's (1997) hypothesis of the optimal stability window to the GOA shelf involves more degrees of freedom than its use on either mid-latitude shelves or the central GOA (where temperature exerts primary control on stratification in the euphotic zone).

All of these considerations suggest that stratification probably does not develop uniformly in space or time on the GOA shelf. The implications are potentially enormous with respect to feeding opportunities for zooplankton in spring. These animals must encounter abundant prey shortly after migrating to the surface from their overwintering depths. Emergence from diapause (a period of reduced metabolism and inactivity) is tightly coupled to the solar cycle, rather than the onset of stratification. Conceivably then, zooplankton recruitment success might depend on shelf physical processes occurring over a period of several months prior to the onset of the bloom. In particular, the magnitude and phasing of the spring bloom might be preconditioned by shelf processes that occurred throughout the preceding summer and winter. Perturbations in the magnitude and phasing of the spring bloom might propagate through the food chain and affect summer and fall feeding success of juvenile fishes (Denman et al. 1989).

3.4.5 Tides

The tides in the GOA are of the mixed type with the principal lunar semi-diurnal (M_2) tide being dominant and the luni-solar diurnal (K_1) tide being, in general, of secondary importance. [redacted] Tidal characteristics (amplitudes and velocities) are strongly influenced by the complex shelf and slope bathymetry and coastal geometry, however. Consequently, spatial variations in the tidal characteristics of these two species are large. For example, Anchorage has the largest tidal amplitudes in the northern GOA, with the M_2 tide being about 3.6 m and the K_1 tide being about 0.7 m. In contrast, the amplitudes of both of these constituents in Kodiak and Seward are less than half those of Anchorage. Foreman et al. (Foreman et al. 2000) found that the cross-shelf flux of tidal energy onto the northwest GOA shelf is enormous and is accompanied by high (bottom) frictional dissipation rates. Their model estimates indicate that the tidal dissipation rate in Kennedy Entrance accounts for nearly 50% of the total dissipation of the M_2 constituent in the GOA. Further, about one-third of the energy of the K_1 tide in the GOA is dissipated in Cook Inlet. Some of the energy lost from tides is available for mixing, which would reduce vertical stratification and enhance the transfer of nutrients into the euphotic zone.

The interaction of the tidal wave with varying bottom topography can also generate shelf waves at the diurnal frequency and generate residual flows. The waves are a prominent feature of the low-frequency circulation along the British Columbian shelf (Crawford 1984, Crawford and Thomson 1984, Flather 1988, Foreman and Thomson 1997, Cummins and Oey 2000) and could affect pycnocline displacements. (The pycnocline is a vertical layer across which water density changes are large and stable.) The model of Foreman et al. (Foreman et al. 2000) predicts diurnal-period shelf waves in the northwest GOA and especially along the Kodiak shelf break. Although no observations are available to confirm the presence of such waves along the Kodiak shelf, their presence could influence biological production here as well as the dispersal of planktonic organisms. Residual flows resulting from non-linear tidal dynamics could (locally) influence the transport of suspended and dissolved materials on the shelf.

Seasonal changes in water-column stratification can also affect the vertical distribution of tidal energy over the shelf through the generation of internal (baroclinic) waves of tidal period. Such motions are likely to occur in summer and fall in the northwestern GOA where the flux of barotropic tidal energy (which is nearly uniformly distributed over the water column) across the shelf break (Foreman et al. 2000) interacts with the highly stratified water column on the shelf. The internal waves generated can have small spatial scales (10s of km) in contrast to the large scale (1,000s of km) of the generating barotropic tidal waves. Moreover, the phases and amplitudes of the baroclinic tides will vary with seasonal changes in stratification. Although no systematic investigation of internal tides on the GOA shelf has been conducted, Danielson (2000) found that the tidal velocities in the ACC near Seward in winter are about 5 cm s^{-1} and are barotropic. However, in late summer, tidal velocities in the upper 50 m are about 20 cm s^{-1} whereas below 100-m depth they are about 5 cm s^{-1}. Internal tides will also displace the pycnocline sufficiently to have biological consequences, including the pumping of nutrients into the surface layer, the dispersal of plankton and small fishes, and the formation of transitory and small-scale zones of horizontal divergence and convergence that affect feeding behaviors (Mann and Lazier 1996). Stratified tidal flows might also be significant for some silled fjords. The interaction of the tide with the sill can enhance mixing and exchange (Farmer and Smith 1980, Freeland and Farmer 1980) and can resupply the inner fjord with nutrient-rich, high-salinity water and plankton through Bernoulli suction effects (Thompson and Golding 1981, Thomson and Wolanski 1984).

3.4.6 Gulf of Alaska Basin

The circulation in the central GOA consists of the cyclonically (counterclockwise) flowing Alaska Gyre, which is part of the more extensive subarctic gyre of the North Pacific Ocean. The center of the gyre is at about 53° N, and 145° to 150° W. The gyre includes the Alaska Current and Stream and the eastward-flowing North Pacific Current along the southern boundary of the GOA. The latter is a trans-Pacific flow that originates at the confluence of the northward-flowing Kuroshio Current and the southward-flowing Oyashio Current in the western Pacific. Some water from the Alaska Stream apparently recirculates into the North Pacific Current, but the strength and location of this recirculation is poorly understood and appears to be extremely variable (Favorite et al. 1976). The North Pacific Current bifurcates off of the western coast of North America, with the northward flow feeding the Alaska Gyre and the southward branch entering the California Current. The bifurcation zone is located roughly along the zero line in the climatological mean for the wind stress curl. The gyral flow reflects the large-scale cyclonic wind-stress distribution over the GOA. Mean speeds of drifters deployed in the upper 150 m of this gyre (far from the continental slope) are 2 to 10 cm s^{-1}, but the variability is large (Thomson et al. 1990). These cyclonic winds also force a long-term average upwelling rate of about 10 to 30 m yr^{-1} in the gyre center (Xie and Hsieh 1995).

The vertical thermohaline structure of the Alaska Gyre is described by Tully and Barber (1960) and Dodimead et al. (1963) and consists of the following components:

1. A seasonally varying upper layer that extends from the surface to about the 100-m depth;

2. A halocline that extends from 100 m to about the 200-m depth over which salinity increases from 33 to 34 psu and temperatures decrease from 6 to 4° C; and

3. A deep layer, extending from the bottom of the halocline to about the 1,000-m depth, over which salinity increases more slowly to about 34.4 psu and temperatures decrease from 4° to 3° C.

Below the deep layer salinity increases more slowly to its maximal value of about 34.7 psu at the bottom.

The seasonal variations of the upper layer reflect the effects of wind-mixing and heat exchange with the atmosphere–essentially one-dimensional mixing processes. The ocean loses heat to the atmosphere from October through March and gains heat from April through September. The upper layer is isohaline and isothermal in winter down to the top of the halocline. At this time, upper-layer salinities range from 32.5 to 32.8 psu, and temperatures range from 4° to 6° C. The upper layer is fresher and colder in the northern GOA and saltier and warmer in the southern GOA. The upper layer gradually freshens and warms in spring, as wind speeds decrease and solar heating increases. A summer mixed layer forms that includes a weak secondary halocline and a strong seasonal thermocline, with both centered at about the 30-m depth. The seasonal pycnocline erodes and upper layer properties revert to winter conditions as cooling and wind-mixing increase in fall.

The halocline is a permanent feature of the Subarctic North Pacific Ocean and represents the deepest limit over which winter mixing occurs within the upper layer. The halocline results from the high (compared with other ocean basins) rates of precipitation and runoff in conjunction with large-scale, three-dimensional circulation and interior mixing processes occurring over the North Pacific (Reid Jr. 1965, Warren 1983, Van Scoy et al. 1991, Musgrave et al. 1992). The strong density gradient of the halocline effectively limits vertical exchange between saline and nutrient-rich deep water and the upper layer. The deep waters of the GOA consist of the North Pacific Intermediate Water (formed in the northwestern Pacific Ocean) and, at greater depths, contributions from the North Atlantic. Mean flows in the deep interior are feeble (1 cm s^{-1}), and the flow dynamics are governed by both the climatological wind stress distribution (Koblinsky et al. 1989) and the global thermohaline circulation (Warren and Owens 1985) modified by the bottom topography. The thermohaline circulation carries nutrient-rich waters into the North Pacific and forces a weak and deep upwelling throughout the region (Stommel and Arons 1960a, 1960b, Reid 1981).

3.4.7 General Research Questions

What physical-chemical processes control primary and secondary production, and in particular, what processes control the timing, duration, and magnitude of the spring bloom on the inner continental shelf, including the inlets, sounds, and fjords?

Does stratification of the water column in the euphotic zone of the ACC depend primarily on the rate at which fresh water spreads offshore as a consequence of three-dimensional circulation and mixing processes associated with ocean dynamics? (Section 35.4.4)

Do physical oceanographic shelf processes in the ACC in the months leading up to the spring bloom precondition the magnitude and sequence of biological events during the spring bloom? (Section 3.4.4)

Does zooplankton recruitment in the ACC depend on shelf physical processes during a "preconditioning period" leading up to the onset of the spring bloom? (Section 3.4.4)

What are the sources of the nutrients in the euphotic zone on the inner shelf in the spring? (Section 3.4.4)

How are exchanges of carbon and nutrients, detritus and plankton, at the shelf break influenced by the interactions of physical processes with the Alaska Stream and the Alaska Current with the complex bathymetry of the northern and western GOA?

What is the effect of eddy structure on nutrient flux across the continental shelf slope? (Section 3.4.4)

How and where does the interaction of the tidal wave with varying bottom topography generate residual flows that transport nutrients and carbon across water mass boundaries on the inner shelf?

Do diurnal-period shelf waves along the Kodiak shelf influence biological production and the dispersal of planktonic organisms? (Section 3.4.5)

3.5 Chemical Oceanography: Marine Nutrients and Fertility

The overall fertility of the GOA depends primarily on nutrient resupply from deep-water sources to the surface layer were plants grow. Rates of carbon fixation by phytoplankton in the euphotic zone are limited seasonally and annually by changing light levels and the kinds and supply rates of several dissolved inorganic chemical species. Three elements–nitrogen, phosphorus, and silicon–are essential to the photosynthetic process (Parsons et al. 1984). Other dissolved inorganic constituents such as iron are also believed to control rates of photosynthesis at some locations and times (Freeland et al. 1997, Martin and Gordon 1988, Pahlow and Riebsell 2000).

Organic matter synthesized by plants in the lighted surface layer is consumed there or sinks down into the deeper water column where some may eventually reach the seabed. The unconsumed portion is oxidized to inorganic dissolved forms by bacteria at all depths. In the euphotic zone, inorganic nutrients excreted by zooplankton and by micronekton and macronekton (fish), liberated by bacterial oxidation (a process referred to as remineralization), or both excreted and liberated are immediately recycled by phytoplankton. (Nekton is swimming marine life.) In contrast, living cells, organic detritus (remains of dead organisms), and fecal pellets that escape the euphotic zone by sinking are remineralized below the lighted upper layer, and the resulting inorganic forms are lost to surface plant stocks. The result of these combined processes leads to vertical distributions of dissolved inorganic nitrogen, phosphorus, and silicon in which the surface concentrations are much lower than those found deeper in the water column. Such is the case for the GOA (Reeburgh and Kipphut 1986). Geostrophic (shaped by the earth's rotation) and wind-forced upwelling and deep seasonal overturn provide local mechanisms that bring nutrient enriched deep water back into the surface layer each year (Schumacher and Royer 1993). Additionally, at depths shallower than about 100 m, tidal mixing resulting from friction across the bottom can interact with the wind-mixed surface layer to provide an intermittent avenue for surface nutrient replenishment during all seasons.

Concentrations of the dissolved inorganic forms of nitrogen (nitrate, nitrite, and ammonia), phosphorus (phosphate), and silicon (silicate) occur at some of the highest levels measured anywhere in the deep waters of the GOA (Mantyla and Reid 1983). A permanent pycnocline, resulting from the relatively low salinity of the upper 120 to 150 m, limits access to this valuable pool, however; deep winter mixing rarely reaches below about 110 m in waters over the deep ocean (Dodimead et al. 1963, Favorite et al. 1976). Although upwelling occurs in the center of the Alaska Gyre, it is believed to be only on the order of a meter (or considerably less) per day (Sugimoto 1993, Xie and Hsieh 1995), a relatively modest rate compared to some regions of high productivity like the Peru or Oregon coastal upwellings. Away from the Alaska Gyre upwelling along the northern continental margin of the GOA, the prevailing winds drive a predominately downwelling environment over the shelf for 7 to 8 months each year. Although this condition usually moderates during the summer, there is little evidence that wind-forced coastal upwelling is ever well developed. Instead, during the period of relaxed downwelling or sporadic and weak upwelling, a rebound of isopycnal (density boundaries; waters having the same densities) surfaces along the shelf edge permits the run-up of dense slope water onto and across the shelf. This subsurface water, containing elevated concentrations of dissolved nutrients, flows into the deeper coastal basins and fjords (Muench and Heggie 1978, Heggie and Burrell 1981). Presumably the timing and duration of this coastal bottom renewal is related to the nature of the Pacific High pressure dominance in the GOA each summer.

The coastal and inshore waters in the northern GOA are also influenced by runoff from a large number of streams, rivers, and glaciers in the rugged coastal margin. In these areas that are largely untouched by agriculture, this input probably contributes little to the coastal nutrient cycle, except possibly as a source for silicon and iron (Burrell 1986). Therefore, the major pool of plant nutrients for water column production in ocean, shelf, and coastal regions is derived from marine sources and resides in the deep waters below the surface production zone.

The major pool of plant nutrients for water column production in ocean, shelf, and coastal regions is in deep waters.

Because light limits carbon fixation during the winter months, there is a strong seasonal signal in nutrient concentrations of the euphotic zone in upper-layer shelf, coastal, and inside waters. During the winter, dissolved inorganic plant nutrients build their concentrations in the deepening wind-mixed layer as deeper, nutrient rich water becomes involved in the seasonal overturn at a time when uptake by phytoplankton is minimal. Under seasonal light limitation, surface nutrient concentrations probably peak in early March, just before the onset of the annual plankton production cycle. By mid- to late-May and early June, euphotic zone nutrients are drawn down dramatically to seasonal lows as the stratification that initiates the spring "bloom" of plant plankton severely restricts the vertical flux of new nutrients (Goering et al. 1973). Nitrate can become undetectable or nearly so during the summer months in many shelf and coastal areas, and ammonia (excreted by grazers) becomes important in sustaining the much-reduced primary productivity. Later in fall, with the onset of the Aleutian Low pressure system and the storms that it produces, a cooling and deepening wind-mixed layer can reinject sufficient new nutrients into a shrinking euphotic zone to initiate a fall plant bloom in some years (Eslinger et al. 2001).

The strong seasonal signal of nutrients and plant stocks evident on the continental shelf is diminished in surface waters seaward of the shelf break in the GOA. The region beyond the continental shelf break is described as "high nutrient, low chlorophyll ". It was believed historically that grazing by a collective of large calanoid copepods (species of zooplankton endemic to the subarctic Pacific) consumed enough plant biomass each year to control the overall productivity below levels needed to completely exhaust the surface nitrogen (Heinrich 1962, Parsons and Lalli 1988).

More recently, iron limitation has been posed as a mechanism controlling primary production in the GOA and in several other offshore regions of the world's oceans (Martin and Gordon 1988). Contemporary research in the GOA has revealed that control of the amount of food produced by phytoplankton through grazing of zooplankters is probably important, although the species of zooplankton involved are not the large calanoid copepods (Dagg and Walser 1987, Frost 1991, Dagg 1993). Production of phytoplankton is thought to be controlled by an assemblage of microzooplankters, microconsumers, represented by abundant ciliate protozoans and small flagellates, rather than by large calanoid copepods (Booth et al. 1993). Because the growth rates of these grazers are higher than those of the plants, it is hypothesized that these microconsumers are capable of efficiently tracking and limiting the overall oceanic productivity by eating the primary producers, the phytoplankton (Banse 1982). The control mechanism is made possible because the plant communities are dominated by very small cells, 10 micrometers or less, that can serve as food for the microconsumers.

A counter-hypothesis asserts that the small size of the plants is actually in response to low levels of iron. It is known that faced with nutrient limitation, phytoplankton communities generally shift to small-sized species whose surface-area-to-volume ratios are high. Resolution of these related ideas is sought in continuing studies of the oceanic production cycle.

Surprising recent observations demonstrate a trend in increasing temperatures in the upper layers that may be causing a shift in the seasonal nutrient balance offshore (Freeland et al. 1997, Polovina et al. 1995). For the first time, there are reports that nitrogen has been drawn down to undetectable levels along line P in the southern GOA out to a distance of 600 km from the coast (Welch 2001). Line P is a an oceanographic transect run by the Canadian government that is the oldest source of data from the southern GOA. In addition, the evidence provided by Welch indicates that the winter mixed layer is shoaling under long-term warming conditions.

An essential issue for the GEM program will be to understand how, at a variety of spatial and temporal scales, the supply rates of inorganic nitrogen, phosphorus, silicon, and other essential nutrients for plant growth in the euphotic zone are mediated by climate-driven physical mechanisms in the GOA. Inorganic nutrient supplies might be influenced by climate changes in the following ways:

- Upwelling in the Alaska Gyre;
- Deep winter mixing;
- Shelf and coastal upwelling and downwelling;
- Vertical transport in frontal zones and eddies; and
- Deep and shallow cross-shelf transports.

In addition to these mechanisms, the ACC may play a role that has yet to be determined in the supply rates of dissolved inorganic nutrients to nearshore habitats (Schumacher and Royer 1993). Finally, the import of marine-derived nitrogen associated with the spawning migrations of salmon and other anadromous fishes has been described as a novel means by which the oceanic GOA enriches the terrestrial margin each year. This allochthonous input (food from an outside source) to the drainages bordering the GOA is clearly important in many freshwater nursery areas hosting the early life stages of Pacific salmon (Finney 1998) and must vary with interannual and longer-term changes in salmon abundance.

3.5.1 General Research Questions

How are the supplies of inorganic nitrogen, phosphorous, silicon, and other nutrients essential for plant growth in the euphotic zone influenced by climate-driven physical mechanisms in the GOA?

What is the role of the Pacific High pressure system in determining the timing and duration of the movement of dense slope water onto and across the shelf to renew nutrients in the coastal bottom waters? (Section 3.5)

Is freshwater runoff a source of iron and silicon that is important to marine productivity in the ACC and other marine waters? (Section 3.5)

Does iron limitation control the species and size distribution of the plankton communities in the offshore areas?

Does zooplankton, especially microzooplankton, control the amount of food produced by phytoplankton in the offshore?

3.6 Biological Oceanography: Plankton and Productivity

3.6.1 Plankton Investigations in the Gulf of Alaska

Much of what is presently understood about the plankton communities and their productivity in the GOA has arisen from several programs examining the open ocean and shelf environments. These programs have included the following:

- U.S.-Canada NORPAC surveys (LeBrasseur 1965);
- Subarctic Pacific Ecosystem Research (SUPER) project of the National Science Foundation (NSF) (Miller 1993);
- The multi-decadal plankton observations from Canadian Ocean Station P (OSP) and Line P (McAllister 1969, Fulton 1983, Frost 1983, Parsons and Lalli 1988);
- Annual summer Japanese vessel surveys by Hokkaido University (Kawamura 1988);
- The Outer Continental Shelf Energy Assessment Program (OCSEAP) by Minerals Management Service (MMS) and National Oceanic and Atmospheric Administration (NOAA) (Hood and Zimmerman 1986); and
- The Shelikof Strait Fisheries Oceanography Cooperative Investigation (FOCI) study by NOAA and NMFS (Kendall et al. 1996).

It is not understood how the quite different ecosystems of lower trophic levels in the northeastern subarctic Pacific Ocean are phased through time and interact at their boundaries over the shelf.

Additional and more recent programs include the North Pacific GLOBEC of the NSF and those supported by the EVOS Trustee Council. The above-mentioned programs and a few other studies provide a reasonably coherent first-order picture of the structure and function of lower trophic levels in the northeastern subarctic Pacific Ocean. A serious gap in the detailed understanding of relationships between the observed inshore and offshore production cycles remains, however–namely how these quite different ecosystems are phased through time and interact at their boundaries over the shelf. As a result, information is lacking about how the effects of future climate change may manifest in food webs supporting higher level consumers.

3.6.2 Seasonal and Annual Plankton Dynamics

The composition, distribution, abundance, and productivity of plant and animal plankton communities in the GOA have been reviewed by Sambrotto and Lorenzen (1986); Cooney (1986); Miller (1993); and Mackas and Frost (1993). In general, dramatic differences are observed between pelagic communities over the deep ocean, and those found in shelf, coastal, and protected inside waters (sounds, fjords, and estuaries). Specifically, the euphotic zone seaward of the shelf edge is dominated year round by very small phytoplankters–tiny diatoms, naked flagellates, and cyanobacteria (Booth 1988). Most are smaller than 10 microns in size, and their combined standing stocks (measured as chlorophyll concentration) occur at very low and seasonally stable levels. It was originally hypothesized that a small group of large oceanic copepods (*Neocalanus* spp. and *Eucalanus bungii*) limited plant numbers and open ocean production by efficiently controlling the plant stocks through grazing (Heinrich 1962). More recent evidence, however, indicates the predominant grazers on the oceanic flora are not the large calanoids (Dagg 1993), but instead abundant populations of ciliate protozoans and heterotrophic microflagellates (Miller et al. 1991a, 1991b, Frost 1993). It has been further suggested that in these high nutrient, low chlorophyll oceanic waters, very low levels of dissolved inorganic iron (coming mainly from atmospheric sources) are ultimately responsible for structuring the composition of the primary producers and consumers (Martin and Gordon 1988, Martin 1991). Close reproductive and trophic coupling between the nanophytoplankton and microconsumers appears to restrict levels of primary productivity below that needed to exhaust all of the seasonally available nitrogen each year (Banse 1982). Moreover, the excreta of the microconsumers is diffuse, with low sinking rates, and is easily oxidized by bacteria. Ammonia (derived from grazer-released urea) is a preferred plant nutrient, and the first oxidation product recycled in this way. Wheeler and Kokkinakis (1990) demonstrated that as long as ammonia is available for the plants, nitrate uptake in the euphotic zone is much reduced. Together, these findings are painting a considerably revised picture of lower trophic level relationships and nutrient balances at the base of the offshore pelagic ecosystem in the GOA.

In contrast, shelf, coastal, and inside waters host a more traditional plankton community in which large and small diatoms and dinoflagellates support a copepod-dominated grazing assemblage (Sambrotto and Lorenzen 1986, Cooney 1986). Here, the annual production cycle is characterized by well-defined spring (and sometimes fall) blooms of large diatom species (most larger than 50 microns) whose productivities are limited annually by the rapid utilization of dissolved inorganic nitrogen, phosphorus, and silicon in the euphotic zone (Eslinger et al. 2001, Ward 1997). These blooms typically begin in late March and early April in response to a seasonal stabilization of the winter-conditioned deep mixed layer. High rates of photosynthesis typically last only 4 to 6 weeks (Goering et al. 1973). Strong periods of wind, tidal mixing, or both during the bloom can prolong these events by interrupting the conditions of light and stability needed to support plant growth. When the phytoplankton bloom is prolonged in this way, its intensity is lessened, but considerably more organic matter is apparently directed into pelagic food webs, rather than sinking to feed seabed consumers (Eslinger et al. 2001). Accelerated seasonal warming and freshening of the upper layers in May and June provide increasing stratification that eventually restricts the vertical flux of new nutrients and limits summer primary productivity to very low levels. In some years, a fall bloom of diatoms occurs in September and October in response to a deepening wind-mixed layer and enhanced nutrient levels. The ecological significance of the fall portion of the pelagic production cycle remains largely undescribed.

In both the ocean and shelf domains, strong seasonal signals occur in standing stocks and estimates of daily and annual rates of production for the phytoplankton and zooplankton. Some of the earliest measurements of photosynthesis at OSP placed the annual primary production in the southern part of the Alaska Gyre at about 50 grams of carbon per square meter per year (g C m^{-2} y^{-1}) (McAllister 1969), or somewhat lower than the overall world ocean average of 70 g C m^{-2} y^{-1}. More recent studies using other techniques, however, have suggested higher annual rates, somewhere between 100 to 170 g C m^{-2} y^{-1} (Welschmeyer et al. 1993). Unlike the production cycle over the shelf, the oceanic primary productivity does not produce an identifiable spring/summer plant bloom. Instead, the oceanic phytoplankton stock remains at low levels (about 0.3 milligrams [mg] of chlorophyll a m^{-3}) year-round for reasons discussed above. In stark contrast, oceanic stocks of zooplankton (upper 150 m) do exhibit marked seasonality. Late winter values of 5 to 20 mg m^{-3} (wet weight) rise to 100 to 500 mg m^{-3} in mid-summer, when upper-layer populations of large calanoids dominate the standing stock. Assuming the zooplankton production is roughly 15% of the oceanic primary productivity (Parsons 1986), annual estimates of zooplankton carbon production estimated from primary productivity range between 8 and 26 g C m^{-2}. Given that the carbon content of an average zooplankter is approximately 45% of the dry weight, and that dry weight is about 15 % of the wet weight (Omori 1969), the carbon production can be converted to estimates of biomass. Results from this calculation suggest that between 119 and 385 g of biomass m^{-2} may be produced each year in the upper layers of the oceanic regime from sources thought to be largely zooplankton.

The shelf, coastal, and inside waters present a mosaic of many different pelagic habitats. The open shelf (depths less than 200 m) is narrow in the east between Yakutat and Kayak Island (20 to 25 km in some places), but broadens in the north and west beyond the Copper River (about 100 to 200 km). The shelf is punctuated by submarine canyons and deep straits, but also rises to extensive shallow shoals at some locations. The rugged northern coastal margin is characterized by numerous islands, coastal and protected fjords, and estuaries. Only PWS is deeper than 400 m.

Although the measurements are sparse, the open shelf and coastal areas of the northern GOA are believed to be quite productive, particularly the region between PWS and Shelikof Strait (Sambrotto and Lorenzen 1986). Coastal transport and turbulence along the Kenai Peninsula, in lower Cook Inlet, and around Kodiak and Afognak islands appears to enhance nutrient supplies during the spring and summer. Annual rates of primary production approaching 200 to 300 g C m^{-2} y^{-1} have been described. In other coastal fjords, sounds, and bays, the estimates of annual primary production range from 140 to more than 200 g C m^{-2} y^{-1} (Goering et al. 1973, Sambrotto and Lorenzen 1986). Assuming again that the annual zooplankton production is roughly 15% of the primary productivity, yearly zooplankton growth in shelf and coastal areas probably ranges between about 21 and 45 g C m^{-2} y^{-1}, or 311 to 667 g m^{-2} y^{-1} wet weight. In PWS, the wet-weight biomass of zooplankton caught in nets (net-zooplankton) in the upper 50 m varies from a low in February of about 10 mg m^{-3} to a high of more than 600 mg m^{-3} in June and July (Cooney et al. 2001a). For selected other coastal areas outside PWS, the seasonal range of zooplankton biomass includes winter lows of about 40 mg m^{-3} to spring/summer highs approaching 5,000 mg m^{-3} (in outer Kachemak Bay, for which a conversion of settled volumes may have been contaminated by large phytoplankton in the samples; see (Cooney 1986)

In addition to strong seasonality in standing stocks and rates of production, plankton communities also exhibit predictable seasonal species succession each year in the oceanic and shelf environments. Over the shelf, the large diatom-dominated spring bloom gives way to dinoflagellates and other smaller forms as nutrient supplies diminish in late May and early June. Ward (1997) described the phytoplankton species succession in PWS. She found that early season dominance in the phytoplankton bloom was shared by the large chain-forming diatoms *Skeletonema, Thalassiosira*, and *Chaetoceros*. Later in June , under post-bloom nutrient restriction, diatoms were dominated by smaller *Rhizosolenia* and tiny flagellates. This seasonal shift in dominance from larger to smaller plant species in response to declining nutrient concentrations and supply rates is commonly observed in other high-latitude systems and is believed to be responsible for driving the succession in the grazing community. Because of the iron limitation in the oceanic regime, the primary producer community is more stable there, with tiny diatoms, microflagellates, and cyanobacteria dominating year-round.

The zooplankton succession is somewhat more complex and involves interchanges between the ocean and shelf ecosystems. In the late winter and spring, the early copepodite stages of *Neocalanus* spp. begin arriving in the upper layers from deepwater spawning populations (Miller 1988, Miller and Nielsen 1988, Miller and Clemons 1988). This arrival occurs in some coastal areas (at depths of more than 400m) in late February and early March, but is delayed about 30 days in the open ocean. Both *Neocalanus* spp. and *Eucalanus bungii* are interzonal seasonal migrators, living a portion of their life cycle in the upper layers as developing copepodites, and later resting in diapause in the deep water preparing for reproduction at depth. While maturing in the oceanic surface water, *Neocalanus plumchrus* and *N. flemingeri* inhabit the wind-mixed layer above the seasonal thermocline (upper 25 to 30 m), while *N. cristatus* (the largest of the subarctic copepods) and *Eucalanus bungii* are found below the seasonal stratification (Mackas et al. 1993). This unusual partitioning of the surface ocean environment by these species has not yet been verified for shelf and coastal waters, although it has been suggested that the partitioning may occur in the deep-water fjords and sounds (Cooney unpublished).

Along with the early copepodites of the interzonal migrators, the late winter and spring shelf zooplankton community also hosts small numbers of *Pseudocalanus* spp., *Metridia pacifica*, *M. okhotensis*, and adult *Calanus marshallae*. Because these copepods must first feed before reproducing, their seasonal numbers and biomass are set by the timing, intensity and duration of the diatom bloom. By May and early June, the abundances of small copepods like *Pseudocalanus* and *Acartia* are increasing, but the community biomass is often dominated by relatively small numbers of very large developmental stages (C4 and C5) of *Neocalanus* (Cooney et al. 2001a). After *Neocalanus* leaves the surface waters in late May and early June for diapause deep below the surface (at locations where depths permit), *Pseudocalanus*, *Acartia*, and *Centropages* (small copepods); the pteropod *Limicina pacifica;* and larvaceans (*Okiopleura* and *Fritillaria*) occur in increasing abundance. Later, from summer to fall and extending into early winter, carnivorous jellyplankters represented by ctenophores, small hydromedusae, and chaetognaths (*Sagitta elegans*) become common. These shifting seasonal dominants are joined by several different euphausiids (*Euphausia* and *Thysanoessa*) and amphipods (*Cyphocaris* and *Parathemisto*) throughout the year. Despite the fact that the subarctic net-zooplankton community consists of a large number of different types of animal (taxa), most of the biomass and much of the abundance in the upper 100 m is accounted for by fewer than two dozen species (Cooney 1986).

3.6.3 Interannual and Decadal-Scale Variation in Plankton Stocks

Few measurements and estimates are available for year-to-year and decadal-scale variability in primary and secondary productivity in all marine environments in the northern GOA (Sambrotto and Lorenzen 1986). Fortunately, some information is available about variable levels of zooplankton stocks. Frost (1993) described interannual changes in net-zooplankton sampled from 1956 to 1980 at Canadian OSP. Year-to-year variations in stocks of about a factor of five were characteristic of that data set, and a slight positive correlation with salinity was observed. Cooney et al. (2001b) examined an 18-year time series of zooplankton settled volumes from eastern PWS collected near salmon hatcheries by the personnel of the Prince William Sound Aquaculture Corporation, Cordova. Once again, annual springtime differences of about a factor of five were apparent in that data. In addition, from 1981 to 1991, settled zooplankton volumes in PWS were also strongly and positively correlated with the strength of the Bakun upwelling index calculated for a location near Hinchinbrook Entrance. This correlation completely disappeared after 1991, however (Eslinger et al. 2001). Also of some interest, the years of highest settled volumes in eastern PWS (1985 and 1989) were only moderate years for zooplankton reported by Incze et al. (1997) for Shelikof Strait, suggesting the Kodiak shelf and PWS regions were phased differently for at least those years. Sugimoto and Tadokoro (1997) report a regime shift in the subarctic Pacific and Bering Sea in the early 1990s that generally resulted in lower

Few measurements are available for variability of marine environment productivity in the northern GOA.

zooplankton stocks in both regions. Perhaps in response to this phenomenon, springtime settled zooplankton volumes in PWS also declined by about 50% after 1991 (Cooney et al. 2001b).

The most provocative picture of decadal-scale change in zooplankton abundance in the GOA is provided by Brodeur and Ware (1992). With the use of spatially distributed oceanic data sets reporting zooplankton biomass from 1956 to 1962, and again from 1980 to 1989, these authors were apparently able to capture large-scale properties of the pelagic production cycle during both positive and negative aspects of the PDO (Mantua et al. 1997). A doubling of net-zooplankton biomass was observed under conditions of increased winter winds responding to an intensified Aleutian Low pressure system (the decade of the 1980s). This sustained doubling of biomass was also reflected at higher trophic levels in the offshore food web (Brodeur and Ware 1995). It is generally believed the observed production stimulation during the decade of the 1980s was created by increased nutrient levels associated with greater upwelling in the Alaska Gyre. The observed horizontal pattern of upper layer zooplankton stocks (Figure 3.16) was an impressive areal expansion (positive PDO) or contraction (negative PDO). Under periods of intensified winter winds, some of the highest oceanic zooplankton concentrations were developed in a band along the shelf edge in the northern regions in the GOA. Unfortunately, data from the shelf itself during this same time period are not sufficient to ascertain how this elevated biomass may have intruded the continental margin or reached the coastal areas.

3.6.4 Factors Effecting Trophic Exchanges Between the Plankton and Larger Consumers

Most would concede that the general theory of trophodynamics articulated by Lindeman (1942) nearly 50 years ago to represent ways in which matter and energy are transferred through aquatic communities (by different levels of producers and consumers) is an overly simplistic picture of complex interactions and non-linear relationships. Useful in the lecture hall as a teaching tool, and successfully applied to certain problems where first-order estimates of production at hypothetical levels are sought based on estimates of plankton productivity, these formulations usually lack any dynamic connection with the physical environment or nutrient levels. They also generally fail to delineate seasonality or other important temporal variability. Nonetheless, because of the ease of their application and the acceptance of certain simplifying assumptions (generalized ecological transfer efficiencies and lumping taxa within trophic levels), the linear food-web or carbon budget approach continues to be used for selected purposes.

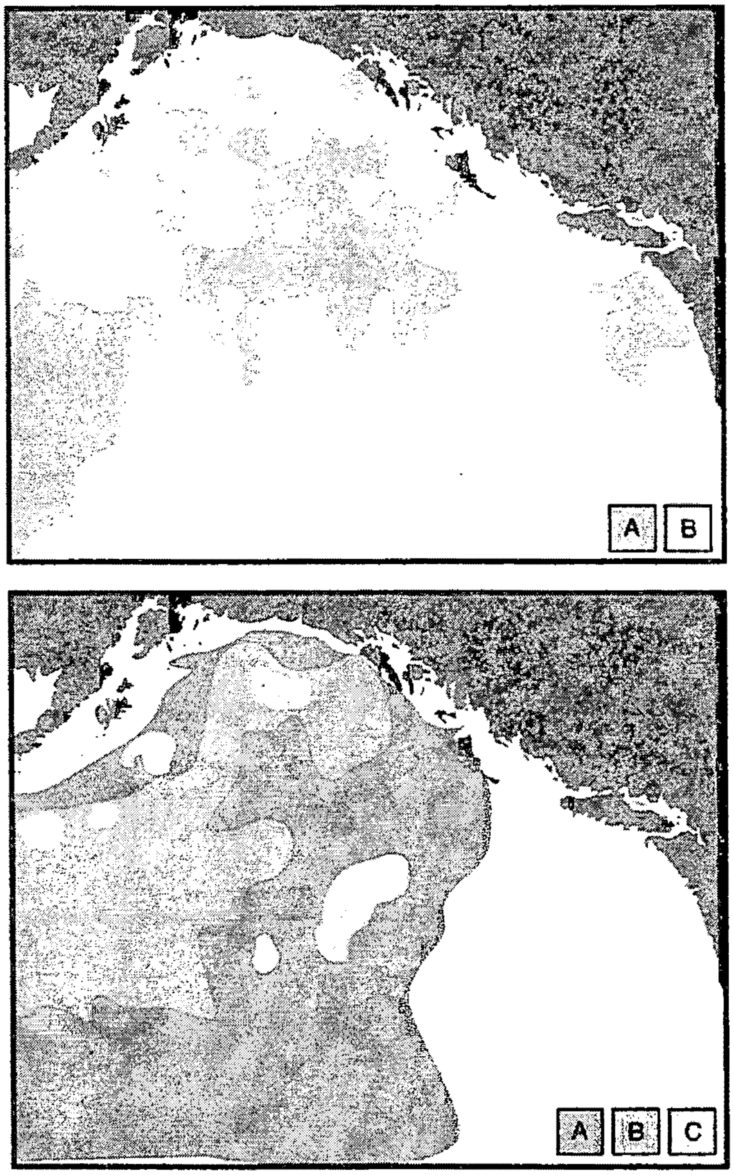


Figure 3.16 Biomass of plankton for the spring and summer period contrasted for a negative PDO period (top) and a positive PDO period (bottom). The shaded boxes present zooplankton biomass as follows: A represents 100 to 200 g/1,000 m^3; B represents 201 to 300 g/m^3, and C represents more than 300 g/m^3.

Bottom-up trophic models of food-web structure supporting the production of fishes, birds, and mammals in open ocean, slope, estuarine, and fjord environments in the GOA were formulated by Parsons (1986) in a synthesis of information compiled primarily as the result of the MMS-funded OCS studies. More recently Okey and Pauly (1998) developed a mass balance formulation with the Ecopath model of trophic mass balance for a PWS food web as the result of the EVOS Restoration Program. These models are certainly instructive at some level of generality, but their usefulness for describing specific climate-related mechanisms that might modify food-web transfers is probably limited by their detachment from the physical environment and their reliance on annually or seasonally averaged stock sizes and productivities.

Instead, it may be more instructive to examine how evolved behavioral traits and other aspects of the life histories of the dominant plankters (and other forage taxa) lend themselves to food-web transfers that could be affected by climate change. To do this, it will be important to study how the biology at lower trophic levels interacts (on a variety of time and space scales) with the physical environment to create enhanced (or diminished) trophic opportunities in the consumer matrix of different habitats and seasonal characterizations that pervade the marine ecosystem in the northern GOA. The compressed nature of the annual plankton production cycle in oceanic, shelf, and coastal waters seemingly places a premium on "timing" as a strategy to maximize the chances for successfully linking consumers to each year's burst of organic matter synthesis. Paul and Smith (1993) found that yellowfin sole replenished their seasonally depleted energy reserves each year in a short period of about 1 month following the peak in primary productivity. This rapid replenishment of energy reserves is presumably possible because of the structural properties of forage populations that occur abundantly during the short and intense production cycle. Patch-dependent feeding is a term used to describe how many consumers respond to the grainy time and space distributions of food in their feeding environments (Valiela 1995). In the case of plankters, which by definition move with the water, temporal and spatial patchiness can be created or dissipated through interactions with (1) physical processes such as vertical and horizontal transport and diffusion, and (2) biological attributes such as rapid growth and swarming or layering in association with feeding, reproductive behaviors, or both.

For example, the more than 2 month maturation process for the large oceanic copepods (*Neocalanus* spp.) growing in the near-surface of the open ocean, shelf, and some coastal environments concludes with a short period (15 to 30 days) in which the biomass peaks each year, is concentrated in the largest (C4 and C5) copepodites, and is compressed into relatively thin layers and swarms contiguous for tens, possibly hundreds of km (Mackas et al. 1993, Cooney 1989, Coyle 1997, Kirsch et al. 2000). In its most concentrated form, this seasonally ephemeral biomass is an important source of food for diving sea birds (Coyle 1997), whales, and planktivorous fishes such as adult Alaska pollock and Pacific herring (Willette et al. 1999). Acoustic observations suggest the degree of plankton swarming or layering depends, in part, on the strength of water column mixing and stability . Numerical models of the production cycle in PWS demonstrated that interannual variations in the timing of the annual peak in zooplankton probably reflects differences in the timing of the earlier phytoplankton bloom each year. Eslinger et al. (2001) reported that the spring diatom bloom varied by as much as 3 weeks from year to year in PWS, but that the annual peak in zooplankton always lagged the plants by about 25 to 30 days. Year-to-year shifts of a week or more in the peak of zooplankton biomass may profoundly influence the effectiveness of food-web transfers to fishes, birds, and other consumers with severe consequences. Pacific herring have apparently evolved a reproductive strategy to place age-0 juveniles in the water column precisely at the time of the mid-summer peak in plankton forage. Failure to successfully provision themselves by missing the most optimal summer feeding conditions may contribute to high rates of winter starvation for age-0 herring in PWS (Cooney et al. 2001b).

In another example, Cooney (1983) reported a possible interaction between the movements occurring over the life cycle of large oceanic calanoid zooplankton, ontogentic migrations and an enrichment of feeding habitats for fishes, birds, and mammals over the shelf forced by localized convergences in the late winter and spring months. As previously mentioned, *Neocalanus* spp. arrive in the surface waters of the deep ocean in March and April each year. Early copepodite stages are presumably carried across the shelf in the wind-forced Ekman flow (upper 60 to 90 m) where they eventually encounter zones of surface convergence (Cooney 1986). *Neocalanus* spp. in the shelf environment depends on the spring diatom bloom for growth and maturation. Because the developing copepodites have an affinity for the upper layers where the phytoplankton production occurs (Mackas et al. 1993), they may be able to counteract regions of downwelling and convergence by continuing to migrate upward in these zones (a few tens of m per day at most). Where they successfully detach themselves from the downwelling water, populations advected shoreward into convergences (possibly in the frontal region of the ACC) will accumulate. These zones of high copepod (and perhaps other taxa) biomass should represent regions of potentially high trophic efficiency for planktivores built and maintained for a few weeks by wind-forced horizontal and vertical transport.

In a related exercise, Cooney (1988) calculated that nearly 10 million metric tons of zooplankton could be introduced to the shelf annually over 1,000 km of coastline in the northern GOA by the wind-forced shoreward Ekman transport each year. If only a portion of this biomass is retained in shelf and coastal food webs, the "lateral input" of ocean-derived zooplankton (much of it represented by the large interzonal calanoids) may partially explain how the seasonally persistent downwelling shelf sustains the observed high annual production at higher trophic levels. Kline (1999a), in studies of carbon and nitrogen isotopes of zooplankton sampled in PWS, found that 50% or more of the diapausing *Neocalanus cristatus* overwintering in the deep water originated from populations outside PWS each year. Similar isotopic signals in herring and other coastal fishes seem to confirm a partial role for the bordering ocean in "feeding" at least some coastal habitats.

Coyle (1997) described the dynamics of *Neocalanus cristatus* in frontal areas along the northern and southern approaches to the Aleutian Islands. In regions near water column instabilities that fostered nutrient exchange for nearby stratified phytoplankton populations, these large oceanic copepods occurred along pycnoclines in subsurface swarms and layers that were in turn attractive feeding sites for diving least auklets. These trophic associations (observed acoustically) formed and dissipated in response to weather and tidal modified forcing of the waters over the shelf north and south of the Aleutian Islands.

Kirsch et al. (2000) described dense layers (10 to 20 m in vertical extent) of C4 and C5 *Neocalanus plumchrus, N. flemingeri,* and *Calanus marshalle* in the upper 50 m of PWS that serve as seasonally important feeding zones for adult Alaska pollock and Pacific herring. Swarming behavior in the upper layers by these copepods, responding to the distribution of their food in the euphotic zone, compresses *Neocalanus* into layers stretching for tens of km that are readily located and utilized by planktivores. Other observations at the time found the layers of copepods were absent or only weakly developed in areas with high mixing energy like outer Montague Strait.

Diel migrations of many taxa bring deep populations into the surface waters each night. The large bodied copepod *Metridia* spp. and many Pacific euphausiids (*Euphausia* and *Thysanoessa*) represent zooplankters that undergo substantial daily migrations from deep to shallow waters at night. A variety of reasons have been proposed for this behavior (Longhurst 1976). Regardless of the "why," vertically migrating populations that build local concentrations near the sea surface during darkness represent another way that behavioral traits are responsible for creating patchiness that may enhance trophic exchange. Cooney (1989) and Stockmar (1994) studied diel and spatial changes in the biomass of net-zooplankton and micronekton in the upper 10 m of the open ocean and shelf habitats in the northern GOA. They found a consistent enrichment of biomass in the surface waters at night caused by *Metridia pacifica* and several different euphausiids that often exceeded daylight levels by a factor of five or six.

Springer, et al. (1996) make a strong case for the enhancement of primary and secondary productivity along the shelf edge of the southeastern Bering Sea. Citing tidal mixing, transverse circulation, and eddies as mechanisms to increase nutrient supplies, this so-called "greenbelt" is described as 60% more productive than the outer-shelf environment and 270% more productive than the bordering deep ocean. Earlier, Cooney and Coyle (1982) documented the presence of a high-density band of upper-layer zooplankton along the shelf edge of the eastern Bering Sea. Comprised primarily of *Metridia* spp., *Neocalanus* spp., and *Eucalanus bungi*, this narrow zone of elevated biomass is apparently also a part of the greenbelt. Although these features have yet to be described for the northern GOA, the present North Pacific GLOBEC study (Weingartner 2000) is monitoring primary productivity and zooplankton stocks along cross-shelf transects that should intercept a shelf-edge greenbelt if one is present in the northern GOA.

Finally, meso and large-scale eddy formation over the shelf and slope regimes may also influence the patchiness of plankton in ways that could be susceptible to changing climate forcing. A permanent feature (eddy) in the coastal water west of Kayak Island is often visible because of entrained sediment from the Copper River. Formed by a branch of the ACC, this eddy may help concentrate plankton populations of the upper layer in ways that could later influence PWS (Reed and Schumacher 1986). Vaughan et al. (2001) and Wang (2001) describe surface eddies in the central region of PWS with implications for the transport and retention of icthyoplankton. These eddies (cyclonic and anticyclonic) are believed to form in response to seasonal changes in freshwater outflow and wind forcing. Large-scale coastal and shelf eddies apparently form near Sitka and propagate north and west around the periphery of the GOA (Musgrave et al. 1992). Similar features on the east coast of the United States have been shown to be long-lived (many months) and capable of sustaining unique biological assemblages as they move through time and space. These same characteristics are also expected for the northern GOA.

3.6.5 Climate Forcing of Plankton Production in the Gulf of Alaska

A major challenge for the GEM program will be to eventually produce a detailed understanding of lower trophic level processes that arise through biological interactions with the spatially distributed geological and physical properties of the northern GOA. This evolving understanding must take into account the flow-through nature of the northern and eastern regions–downstream from southern Southeast Alaska and Northern Canada (through the ACC) and also downstream from portions of the southern oceanic Subarctic and Transition Zone domains (through the North Pacific and Alaska currents). The "open" condition places increasing importance on understanding levels of plankton imports (from the south) and exports (to the west) in the periphery of the GOA affected by the ACC (Napp et al. 1996) and shelf-break flows (Alaska Current and Alaska Stream). It will also be necessary to understand the effects that the open ocean gyre may exert on shelf and coastal plankton stocks and their seasonal and annual production within the northern GOA. Here too the import (or export) of nutrients, organic detritus, and living plankton stocks to (or from) the shelf must be evaluated under different conditions of climate and weather.

The picture that emerges from the aggregate of previous and ongoing plankton studies portrays a large oceanic ecosystem forced strongly by physical processes that are meteorologically driven. Physical processes such as deep and shallow currents, large-scale and localized upwelling and downwelling, seasonally phased precipitation, and runoff may bring about changes in the ecosystem. The reproduction, growth and death processes of the plants and animals of the oceanic ecosystem appear to be responding primarily to marked seasonality and interannual and longer-period shifts in the intensity and location of the winter

Aleutian Low pressure system. Increased upwelling in the offshore Alaska Gyre may promote higher rates of nutrient renewal in the oceanic surface waters with attendant increases in primary and secondary productivity. Elevated wind-forcing probably accelerates the transport of upper-layer oceanic zooplankton shoreward to the shelf edge and beyond. The frequency and degree to which this ocean-derived biomass "feeds" the food webs of the continental shelf and coastal areas will depend, in part, on biological interactions with a large array of physical processes and phenomena. Processes and phenomena active in regions of horizontal and vertical currents associated with oceanographic fronts, eddies, coastal jets, shelf-break flows, and turbulence are expected to have a strong influence on the movement of ocean biomass onto the shelf and coastal areas. The actual effect of such processes and phenomena on distribution of oceanic biomass also depends on responses of plankton production to changes in levels of freshwater runoff in these regions, and on the seasonal and longer cycles in temperature and salinity. Specific mechanisms by which surface zone nutrient levels are cycled and maintained in the variety of different habitats that compose the open shelf and rugged coastal margins must be understood in much greater detail to be useful to the overall GEM mission.

It seems likely that the sophisticated understanding sought by the GEM program of climate influences on the coupled nutrient and plankton production regimes that support selected consumer stocks may have to come from studies that abandon the practice of lumping taxa within broad ecologically functional units, and instead focus on "key species." Fortunately, the subarctic pelagic ecosystem (oceanic, shelf, and coastal) is dominated by a relatively small number of plankton species that serve as major conduits for matter and energy exchange to higher-level consumers each year. In the case of the zooplankton, fewer than 50 species within a handful of major taxa comprise 95% or more of the abundance and biomass throughout the year. Because of this pattern of dominance, and further because of the different life history strategies employed by these species, a more comprehensive understanding of their ecological roles is both necessary and feasible. A decision to conduct dominant species ecology must be understood at all levels of the study so that, for instance, technicians conducting future stomach analyses of fishes, birds, or mammals will report not just "large copepods and amphipods," but rather *Neocalanus cristatus* and *Parathemisto libellula*. This nuance holds particular importance for future modelers working on numerical formulations that include "plankton." Without this degree of specificity, it is unlikely that further (field and numerical) studies will forge the understanding of lower trophic level function sought by the GEM program in the northern GOA.

3.6.6 General Research Questions

What are the relationships between the inshore (watersheds, intertidal-subtidal, and ACC) and offshore production cycles; how are the inshore and offshore phased through time; and how do they interact at their boundaries over the shelf?

- How are the relationships between offshore and inshore production manifested in food webs supporting birds, fish and mammals?
- How are the effects of future climate change manifested in inshore and offshore food webs supporting birds, fish and mammals?

What are the changes in abundance of the individual species of large copepods, amphipods and euphausiids that make up the bulk of the secondary production in the inshore and offshore GOA?

3.7 Nearshore Benthic Communities

Because the GOA covers a vast and diverse area, its benthic communities exhibit tremendous variation (Feder and Jewett 1986). As in any marine benthic system, however, the composition, functioning, and dynamics of the GOA benthic communities change predictably with certain universally important variables. The most important two environmental variables are water depth and substratum type (Rafaelli and Hawkins 1996). The following depth zones are typically distinguished:

- The intertidal zone;
- The shallow subtidal zone (bounded by depth of light penetration sufficient for photosythesis of benthic algae);
- The continental shelf (to about 200 m); and
- The continental slope (from 200 to 4,000 m).

The most fundamental substratum distinctions are hard bottom (rocks, boulders, cobbles) and soft bottom (mobile sedimentary habitats like sands and muds). Within these two types, geomorphology varies substantially, with biological implications that often induce further habitat partitioning (Page et al. 1995, Sundberg et al. 1996).

Understanding of community composition and seasonal dynamics of GOA benthos has grown dramatically over the past 30 years, with two distinct pulses of research. First, in contemplation of exploration and development of the oil and gas resources of the region, the MMS, NOAA NMFS, and Alyeska Consortium funded geographically focused benthic survey and monitoring work in the 1970s. This work provided the first windows into the quantitative benthic ecology of the region. Focus was most intense on lower Cook Inlet, the Aleutian Islands, the Alaska Peninsula, Kodiak Island, and northeast GOA, including the Valdez Arm in PWS (Rosenberg 1972, Hood and Zimmerman 1986). The second phase of growth in knowledge of the benthos of the GOA region was triggered by the EVOS in 1989. This work had broad geographic coverage of the rocky intertidal zone. The area receiving the most intense study was PWS, where the spill originated. Geographic coverage also included two other regions, the Kenai Peninsula-lower Cook Inlet and the Kodiak archipelago-Alaska Peninsula (Page et al. 1995, Gilfillan et al. 1995a, Gilfillan et al. 1996b, Highsmith et al. 1994b, Highsmith et al. 1996, Houghton et al. 1996a, Houghton et al. 1996b, Sundberg et al. 1996). Some of this benthic study following the oil spill was conducted in other habitats (soft substrata [Driskell et al. 1996]) and at other depths (shallow and deep subtidal habitats (Houghton et al. 1993, Armstrong et al. 1995, Dean et al. 1996a, Dean et al. 1996b, Dean et al. 1998, Dean et al. 2000, Feder and Blanchard 1998, Jewett et al. 1999). Herring Bay on Knight Island in PWS was a site of especially intense monitoring and experimentation on rocky intertidal communities following the oil spill (van Tamelen et al. 1997).

3.7.1 Intertidal Communities

The intertidal habitat is the portion of the shoreline in between the high and low (0.0-m datum) tide marks. This intertidal zone occupies the unique triple interface among the land, sea, and air. The land provides substrate for occupation by intertidal organisms, the seawater the vehicle to supply necessary nutrients, and the air a medium for passage of solar energy, yet a source of physical stresses (Connell 1972, Underwood and Denley 1984, Peterson 1991). Interfaces between separate systems are locations of typically high biological activity. As a triple interface, the intertidal zone is exceptionally rich and biologically productive (Ricketts and Calvin 1968, Leigh et al. 1987). Wind and tidal energy combine to subsidize the intertidal zone with planktonic foods produced in the photic (sun-lit) zone of the coastal ocean. Runoff from the adjacent land mass injects new supplies of inorganic nutrients to help fuel coastal production of benthic algae, although such runoff in Alaska is typically nutrient-poor and can be very turbid (Hood and Zimmerman 1986). The consequent abundance and diversity of life and life forms in the intertidal zone serves many important consumers, coming from land, sea, and air, and including humans. The aesthetic, economic, cultural, and recreational values of the intertidal zone and its resources augment its significance, especially in the GOA region (Peterson 2001).

The biota of intertidal habitats varies with changes in physical substrate type, wave energy regime, and atmospheric climate (Lubchenco and Gaines 1981). Substrata in the GOA intertidal zone differ as a function of size, ranging from immobile rock walls and platforms, to boulders and cobbles, to gravel, to sands, and finally to muds at the finest end of this particle-size spectrum. Rock surfaces in the intertidal zone are populated by epibiota, which are most commonly attached macro- and microalgae; sessile, or immobile, suspension-feeding invertebrates; and mobile grazing invertebrates, as well as predatory seastars and gastropods (Connell 1972, Rafaelli and Hawkins 1996). Unconsolidated (soft) substrata–the sands and muds–are occupied by large plants in low-energy environments, such as marshes, and microalgae and infaunal (buried) invertebrates in all energy regimes (Peterson 1991). Mobile scavenging and predatory invertebrates occur on both types of substratum. Intertidal communities vary with wave energy because of biomechanical constraints (especially on potentially significant predators), changing levels of food subsidy, and interdependencies between wave energy and substratum type (Leigh et al. 1987, Denny 1988). Intertidal communities tend to be most luxurious in temperate climates; ice scour and turbid fresh water limit intertidal biota at high latitudes such as those in the eastern GOA. The rocky intertidal communities of the Pacific Northwest, including the rocky shores of islands in the GOA region, are highly diverse, although less so than those in Washington. These communities are also productive, although limited by disturbance of winter storms and reduced solar insulation (Bakus 1978).

The rocky intertidal ecosystem may represent the best understood natural community of plants and animals on earth. Ecologists realized more than 40 years ago that this system was uniquely well suited to experimentation because the habitat was accessible and basically two-dimensional and the organisms were manipulable and observable. Consequently, ecological science has used sophisticated experimental manipulations to produce a detailed understanding of the complex processes involved in determining patterns of distribution and abundance of rocky intertidal organisms (Paine et al. 1996, Dayton 1971, Connell 1972, Underwood and Denley 1984). Plants and animals of temperate rocky shores exhibit strong patterns of vertical zonation in the intertidal zone. Physical stresses tend to limit the upper distributions of species populations and to be more important higher onshore; competition for space and predation tend to limit distributions lower on the shore. Surface space for attachment is potentially limiting to both plants and animals in the rocky intertidal zone. In the absence of disturbance, space becomes limiting, and competition for that limited space results in competitive exclusion of inferior competitors and monopolization of space by a competitive dominant. Physical disturbance, biological disturbance, and recruitment limitation are all processes that can serve to maintain densities below the level at which competitive exclusion occurs (Menge and Sutherland 1987). Because of the importance of such strong biological interactions in determining the community structure and dynamics in this system, changes in abundance of certain keystone species can produce intense direct and indirect effects on other species that cascade through the ecosystem (Menge et al. 1994, Wootton 1994, Menge 1995), (Paine et al. 1996).

Intertidal communities occupying unconsolidated sediments (sands and muds) are quite different from those found on rocky shores (Peterson 1991). These soft-bottom communities are composed of infaunal (buried) invertebrates, mobile microalgae, and abundant transient consumers, such as shorebirds, fishes, and crustaceans (Rafaelli and Hawkins 1996). Macroalgae are sparse, and are found attached to large shell fragments or other stable hard substrata. In very low energy environments, large plants, such as salt marsh grasses and forbs high on shore and seagrasses low on shore, occur in intertidal soft sediments (Peterson 1991). The large stretch of intertidal soft-sediment shore in between those vegetated zones has an empty appearance, which is misleading. The plants are microscopic and productive; the invertebrate animals are buried out of sight. The soft-bottom intertidal habitat represents a critically important feeding ground, especially for shorebirds, because the flat topography allows easier access than is provided by steep rocky coasts and because invertebrates without heavy protective calcium carbonate shells are common, particularly polychaetes and amphipods (Peterson 1991).

The intertidal shorelines of the GOA exhibit a wide range of habitat types. True soft-sediment shores are not common, except in Cook Inlet. Marshes, fine-grained and coarse-grained sand beaches, and exposed and sheltered tidal flats represent a small fraction of the coastline in the GOA. Sheltered and exposed rocky shores, wave-cut platforms, and beaches with varying mixtures of sand, gravel, cobble, and boulders are the dominant habitats in this region (Page et al. 1995, Sundberg et al. 1996). Abundance, biomass, productivity, and diversity of intertidal communities on the shores of the eastern GOA with nearby glaciers are depressed by proximity to sources of runoff from glacier ice melt. The islands in PWS and the Aleutian Islands, for example, have richer intertidal communities than the mainland of the northeast GOA, and the intertidal communities of Kodiak and Afognak tend to be richer than those of the Shelikof Strait mainland on the Alaska Peninsula (Bakus 1978, Highsmith et al. 1994b). Glacier ice melt depresses intertidal biotic communities by introducing turbidity and freshwater stresses.

Winter ice scour seasonally denudes epibiota along the Cook Inlet shores (Bakus 1978). Intense wave exposure can cause substratum instability on intertidal cobble and boulder shores, thereby removing intertidal epibiota directly through abrasion (Sousa 1979). Shores with well rounded cobbles and boulders have accordingly poorer intertidal biotas than those with reduced levels of physical disturbance. Bashing from logs also represents an agent of disturbance to those rocky shores exposed to intense wave action in this region (Dayton 1971). Consequently, exposed rocky coastlines may experience more seasonal fluctuations in epibiotic coverage than communities on similar substrata in protected fjords and embayments (Bakus 1978).

The rocky intertidal shores of the spill area exhibit a typical pattern of vertical zonation, although the particular species that dominate vary in importance as a function of changing habitat conditions (Highsmith et al. 1996, Houghton et al. 1996a, Houghton et al. 1996b). Vertical zonation on intertidal rocky shores is a universal feature, caused by a combination of direct and indirect effects of height-specific duration of exposure to air (Paine 1966, Connell 1972).

The uppermost intertidal zone on rocky shores of the GOA is characterized by a dark band of the alga *Verruccaria.* The rockweed (*Fucus gardneri*) dominates the upper intertidal zone, which also includes two common barnacles (*Balanus glandula* and *Chthamalus dalli*), two abundant limpets (*Tectura persona* and *Lottia pelta*), and the periwinkle (*Littorina sitkana*) (SAI 1980, Hood and Zimmerman 1986, Highsmith et al. 1994b).

The middle intertidal zone commonly has even higher cover of *Fucus,* along with beds of blue mussels (*Mytilus trossulus*), the periwinkle (*Littorina scutulata*), barnacles, and the predatory drilling snail (*Nucella lamellosa and N. lima*) (Carroll and Highsmith 1996). In the low intertidal zone, a red alga (*Rhodymenia palmata*) often is dominant, although mussel beds often occupy large areas and the grazing chitons (*Katharina tunicata, Mopalia mucosa,* and *Tonicella lineata*) and predatory seastars (*Leptasterias hexactis* and others) occur here (SAI 1980, Highsmith et al. 1994b). The blue mussel is a very significant member of this community because it is a potential competitive dominant (VanBlaricom 1987) and because its byssus and between-shell interstices provide a protected habitat for a diverse suite of smaller mobile invertebrates, including isopods, amphipods, polychaetes, gastropods, and crabs (Suchanek 1985).

Abundances of rocky intertidal plants and animals in the GOA are controlled by the same suite of factors that affect rocky shore abundances and dynamics elsewhere, especially in the Pacific Northwest. Physical factors, such as wave action from winter storms, exposure to air high on shore, ice scour, and low salinity and turbidity from glacial and land runoff, have important effects on wave-exposed areas (Dayton 1971, Dayton 1975, Bakus 1978).

Biological controls also exert significant influences. Probably the most significant of these likely controlling factors for intertidal biota are predation and recruitment limitation. Predation by seastars is an important control of invertebrate prey population abundances and, therefore, of community composition low on intertidal rocky shores (Paine 1966, Dethier and Duggins 1988). Because blue mussels are typically the preferred prey and represent the dominant competitor for potentially limited attachment space, this predation by seastars has important cascading effects of enhancing abundances of poorer competitors on the rock surfaces (Paine 1966). Predation by gastropods occasionally helps control mussel abundances (Carroll and Highsmith 1996) and barnacle populations higher on shore in the GOA (Ebert and Lees 1996). Shorebird predation, especially by black oystercatchers, is also known to limit abundances of limpets on horizontal rock surfaces of the Pacific Northwest intertidal zones, and this process can be readily disrupted by human inference with the shy shorebirds (Lindberg et al. 1998). The presence of numerous strong biotic interactions in this rocky intertidal community of the GOA led to many indirect effects of the EVOS in this system (Peterson 2001). Because of the influence of current flows and mortality factors such as predation in the water column, larval recruitment can also limit population abundances of marine invertebrates on intertidal rocky coasts (Gaines and Roughgarden 1987, Menge and Sutherland 1987). With a short warm season of high production in the GOA, the potential for such recruitment limitation seems high, but process studies to characterize and quantify this factor have not been conducted in the GOA. Changes in primary production, water temperature (and thus breeding season), and physical transport dynamics associated with regional climate shifts could reasonably be expected to regulate the intensity of recruitment limitation on some rocky shores in the GOA.

The consequences of change caused by various natural and human-driven factors on the structure and dynamics of the rocky intertidal communities are not well developed in the scientific literature. For example, human harvest by fisheries or subsistence users of important apex predators that exert top-down control on intertidal communities could cause substantial cascading effects through the system. But the seastars and gastropods that are the strong predatory interactors in this community in the GOA region are not targets for harvest. The mussels that are taken in subsistence harvest provide important ecosystem services as structural habitat for small invertebrates (Suchanek 1985), as a dominant space competitor (Paine 1966), and as a widely used prey resource (Peterson 2001), but mussels do not appear limited in abundance in the GOA region.

Oceanographic processes related to climate change, either natural or human-driven through global warming, have the potential to either enhance or reduce recruitment of component invertebrate species of the rocky intertidal communities, but studies of the connections between coastal physical dynamics and shoreline communities are in their infancy (Caley et al. 1996). Perhaps the best documented driver of change in composition and dynamics of rocky intertidal communities is the impact of oil spills. The cleanup treatments after the spill, either dispersants (Southward and Southward 1978) or pressurized washes (Mearns 1996), have far more serious impacts than the oil itself. Because of the important strong interactions among species in rocky shore communities, the multiple indirect effects of oil spills on this system take about a decade to work their way out of the system (Southward and Southward 1978, Peterson 2001). Intensive sampling and experimental work on rocky intertidal communities on sheltered shores in PWS following the EVOS make this region data-rich relative to most other Alaskan shores.

Intertidal soft sediments in the spill region of the GOA typically possess lower biomass of macroalgae and invertebrates than corresponding rocky shores at the same elevations (SAI 1980, Highsmith et al. 1994b). The taxonomic groups that dominate intertidal soft bottoms are polychaete worms, mollusks (especially bivalves), and amphipods (Driskell et al. 1996). Sandy sediments have higher representation by suspension-feeding invertebrates, whereas finer, muddy sediments are dominated by deposit-feeding species (Bakus 1978, Feder and Jewett 1986). Intertidal sandy beaches are habitat for several large suspension-feeding clams in the GOA that represent important prey resources for many valued consumers and that support commercial, recreational, and subsistence harvest (Feder and Kaiser 1980). Most important are the littleneck clam (*Protothaca staminea*), the butter clam (*Saxidomus giganteus*), the razor clam (*Siliqua patula*), the cockle (*Clinocardium nuttallii*), the pink-neck clam (*Spisula polynyma*), the gapers (*Tresus nuttallii* and *T. capax*), and others (Feder and Paul 1974). In mudflats, such as those along the shores of Cook Inlet, dense beds of a deposit-feeding clam, *Macoma balthica*, and the soft-shell clam (*Mya arenaria*) frequently occur (Feder et al. 1990). These two relatively soft-shelled clams are significant food resources for many seaducks, and the hard-shelled clams are important prey for sea otters

(Kvitek and Oliver 1992, Kvitek et al. 1992), black and brown bears (Bakus 1978), and several invertebrate consumers. Intertidal soft-bottom habitats are also important feeding grounds for shorebirds and for demersal (deep-water) fishes and crustaceans (Peterson 2001). In addition to macrofaunal invertebrates, smaller meiofaunal invertebrates are abundant on intertidal sedimentary shores. Macrofauna describes animals that are retained on a 0.5-mm mesh; meiofauna refers to animals passing through a 0.5-mm mesh but retained on 0.06-mm mesh; and microfauna are animals smaller than 0.06 mm. Nematode worms and harpacticoid copepods are the most common meofaunal taxa in the GOA region (Feder and Paul 1980b). Harpacticoids serve an important role in the coastal food chain as prey for juvenile fishes, including salmonids (Sturdevant et al. 1996).

Little information exists on the dynamics of long-term change in structure and composition of intertidal communities in soft sediments anywhere. Some of the best understanding of important processes actually comes from the northern GOA region. The Alaska earthquake of 1964 had a tremendous influence on soft-sediment intertidal communities because of the geomorphological modifications of habitat (NRC 1971). Uplift of the shoreline around Cordova, for example, was great enough to elevate the sedimentary shelf habitat out of the depth range that could be occupied by many species of clams. Clam populations in Cordova, a town once called the clam capital of the world, have never recovered from the earthquake. The re-invasion of sea otters has similarly caused tremendous changes in clam populations in shallow soft-sediment communities of the northern GOA, mostly in subtidal areas, but also in intertidal sedimentary environments (Kvitek et al. 1992).

Human impacts can cause change in soft-sediment intertidal communities as well. Probably the most common means by which human activities modify soft-sediment communities in intertidal habitats is through alteration of sediments themselves. The application of pressurized wash after the EVOS, for example, eroded fine sediments from intertidal areas (Driskell et al. 1996) and may be responsible for long delay in recovery of clams and other invertebrates because of a slow return of sediments (Coats et al. 1999, Shigenaka et al. 1999). Addition of organic enrichment can stimulate growth, abundance, and production of opportunistic infaunal invertebrates such as several polychaetes and oligochaetes in intertidal sediments. Such responses were documented following the EVOS (Gilfillan et al. 1995a, Jewett et al. 1999), presumably because the oil itself represented organic enrichment that entered the food chain through enhanced bacterial production (Peterson 2001). Other types of organic enrichment, such as biochemical oxygen demand in treated wastewater from municipal treatment facilities or industrial discharges, can create these same responses. Deposits of toxic heavy metals from mining or other industrial activities and of toxic synthetic organic or natural organic contaminants, like PAHs in oil, can cause change in intertidal benthic communities by selectively removing sensitive taxa such as echinoderms and some crustaceans (Jewett et al. 1999).

Intertidal communities are open to use by consumers from other systems. The great extent and importance of this habitat as a feeding grounds for major marine, terrestrial, and aerial predators render the intertidal system a key to integrating understanding of the function in the entire coastal ecosystem (Peterson 2001). The intertidal habitats of the GOA are critically important feeding grounds for many important consumers:

The intertidal habitats of the GOA are critically important feeding grounds for marine, terrestrial, and avian consumers.

- Marine–sea otters, juvenile Dungeness and other crabs, juvenile shrimps, rockfishes, cod, cutthroat trout, and Dolly Varden char in summer, and juvenile fishes of other stocks exploited commercially, recreationally, and for subsistence, including pink and chum salmon;
- Terrestrial–brown bears, black bears, river otters, Sitka black-tailed deer, and humans; and
- Avian–black oystercatchers and other shorebirds, harlequin ducks, surf scoters, goldeneyes, and other seaducks, and bald eagles.

Intertidal gravels in anadromous streams are important spawning grounds for pink salmon, especially in PWS. Therefore, the intertidal habitat provides vital ecosystem services in the form of prey resources, spawning habitat, and nursery, as well as human services in the form of commercial, recreational, and subsistence harvest of shellfishes and aesthetic, cultural, and recreational opportunities. In short, a habitat that represents only a small fraction of the total area of the seafloor may be the most valuable for the services it provides to the coastal ecosystem and to humans.

3.7.2 Subtidal Communities

The subtidal habitat is the portion of the seafloor found at depths below the low tide (0.0 m datum) mark on shore. This habitat includes a relatively narrow band of shallow subtidal bottom at depths in the photic zone (the zone penetrated by light), where plants can live, and a large area of unlit seafloor, the deep subtidal bottom extending across the continental shelf and slope to depths of 4,000 m in the GOA (Feder and Jewett 1986). The depth to which sufficient light penetrates to support photosynthesis and the slope of the subtidal seafloor determine the width of the shallow subtidal zone. Along a tectonic coastline like the GOA, depth gradients are typically steep. In addition, injection of turbidity from glacier ice melt along the coast reduces light penetration through the seawater. These factors combine to produce a shallow subtidal zone supporting benthic plant production in the region of the spill that is very narrow. Consequently, the vast majority of the subtidal ecosystem, the deep subtidal area on the continental shelf and slope, depends on an energy subsidy in the form of inputs of organic matter from other marine and, to some small extent, even terrestrial habitats. These organic inputs include most importantly detritus from production of intertidal seaweeds and from shallow subtidal seagrasses, seaweeds, and kelps, as well as particulate inputs from phytoplankton, zooplankton, and zooplankton fecal pellets sinking down from the photic zone above to settle on the seafloor. In addition, the carcasses of large animals such as whales, other marine mammals, and fishes occasionally sink to the bottom and provide large discrete packages of detritus to fuel subsequent microbial and animal production in the deep subtidal ecosystem.

Although narrow, the shallow subtidal zone in which primary production does occur is of substantial ecological significance. Many of these vegetated habitats, especially seagrass beds, macrophyte beds, and kelps, provide the following:

1. Nursery grounds for marine animals from other habitats;
2. Unique habitat for a resident community of plant-associated animals;
3. Feeding grounds for important consumers, including marine mammals, seaducks, and many fishes and shellfishes; and
4. A source of primary production for export as detritus to the deeper unlit seafloor ecosystem (Schiel and Foster 1986, Duggins et al. 1989).

In the spill area, eelgrass (*Zostera marina)* beds are common in shallow sedimentary bottoms at the margins of protected embayments (McRoy 1970), whereas on shallow rocky subtidal habitats, the kelps *Agarum, Laminaria,* and *Nereocystis* form dense beds along a large fraction of the coast (Calvin and Ellis 1978, SAI 1980, Dean et al. 1996a). Productivity estimates in wet weight for larger kelps *Nereocystis* and *Laminaria* in the northeastern GOA range up to 37 to 72 kg/m^2/yr (O'Clair and Zimmerman 1986). In this shallow subtidal zone, primary production also occurs in the form of single-celled algae. These microbial plants include both the phytoplankton in the water column and benthic microalgae on and in the sediments and rocks of the shallow seafloor. Both the planktonic and the benthic microalgae represent ecologically important food sources for herbivorous marine consumers. The typically high turnover rates and high food value of these microalgal foods in the shallow subtidal zone helps explain the high production of invertebrate and vertebrate consumers in this environment.

The sessile or slow-moving benthic invertebrates on the seafloor represent the bulk of the herbivore trophic level in the subtidal ecosystem. This benthic invertebrate fauna in the shallow subtidal zone differs markedly as a function of bottom type (Peterson 1991). Rocky bottoms are inhabited by epifaunal benthic invertebrates, such as sponges, bryozoans, barnacles, anthozoans, tunicates, and mussels. Sand and mud bottoms are occupied largely by infaunal (buried) invertebrates, such as polychaete worms, clams, nematodes, and amphipods. The feeding or trophic types of benthic invertebrates vary with environment, especially with current flow regime (Rhoads and Young 1970). Under more rapid flows, the benthos is dominated by suspension feeders, animals extracting particulate foods out of suspension in the water column. Under slower flows, deposit feeders dominate the benthos, feeding on organic materials deposited on or in the seafloor.

The benthos also includes some predatory invertebrates, such as seastars (for example, leather star, *Dermasterias imbricata,* and sunflower star, *Pycnopodia helianthoides*), crabs (for example, helmet crab, *Telmessus cheiragonus*), some gastropods, and some scavenging invertebrates (Dean et al. 1996b). Benthic invertebrates of soft sediments are distinguished by size, with entirely different taxa and even phyla occurring in the separate size classes. Macrofauna include the most widely recognized groups such as polychaete worms, clams, gastropods, amphipods, holothurians, and seastars (Hatch 2001, Driskell et al. 1996). Meiofauna include most prominently in the GOA nematodes, harpacticoid copepods, and turbellarians (Feder and Paul 1980b). Finally, microfauna include most prominently foraminifera, ciliates, and other protozoans. Because the actual species composition of the benthos changes with water depth, the shallow and deep subtidal benthic faunas in the spill zone hold few species in common. Soft-sediment communities of Alaska are best described and understood in various locations within PWS, as a consequence of the intense study after the oil spill.

The shallow subtidal rocky shores that are vegetated also include suites of benthic invertebrates unique to those systems. These benthic invertebrates either directly consume the large plants, such as sea urchins, or else are associated with the plant as habitat. Those species that depend upon the plant as habitat, such as several species of amphipods, crabs and other crustaceans, gastropods, and polychaetes, often are grazers as well, taking some mixture of macrophytic and epiphytic algae in their diets. Grazing by sea urchins on kelps is sufficiently intense in the absence of predation on the urchins, especially by sea otters in the spill area, to create what are known as "urchin barrens" in which the macrophytic vegetation is virtually removed from the seafloor (Estes and Palmisano 1974, Simenstad et al. 1978). In fact, this shallow subtidal community on rocky shores of the GOA represents the best example in all of marine ecology of a system controlled by top-down predation. Sea otters control abundance of the green sea urchin, *Strongylocentrotus droebachiensis.* When released from that otter predation, sea urchin abundance increases to create fronts of urchins that overgraze and denude the kelps and other macroalgae, leaving only crustose forms behind (Simenstad et al. 1978). This loss of macroalgal habitat then reduces the algal associated invertebrate populations and the fishes that use the vegetated habitat as nursery. These reductions in turn can influence productivity and abundance of piscivorous seabirds (Estes and Palmisano 1974). Recently, reduction of traditional marine mammal prey of killer whales has induced those apex consumers to switch to eating sea otters in the Aleutians, thereby extending this trophic cascade of strong interactions to yet another level (Estes et al. 1998, Estes 1999).

Predation and biogenic habitat influence the shallow subtidal community on rocky shores of the GOA.

Consequently, the shallow subtidal community on rocky shores of the GOA is strongly influenced by predation and provision of biogenic habitat (Estes and Duggins 1995). Human disruption of the apex predators by hunting them (as historically occurred on sea otters [Simenstad et al. 1978]) or by reducing their prey (as may conceivably be occurring in the case of the Steller sea lions and harbor seals through overfishing their own prey fishes [NRC 1996]) has great potential to create tremendous cascading effects through the shallow subtidal benthic ecosystem. Furthermore, if concentration and biomagnification of organic contaminants such as PCBs, DDT, DDE, and dioxins in the tissues of apex predators, in particular in transient killer whales (Matkin unpublished data), causes impaired reproductive success, then human industrial pollution has great potential to modify these coastal subtidal communities on rocky shores.

The shallow subtidal benthic communities in soft sediments of the GOA region function somewhat differently from their counterparts on rocky substrata. These communities are important for nutrient regeneration by microbial decomposition and for production of benthic invertebrates that serve as prey for demersal shrimps, crabs, and fishes. In some protected areas within bays, however, the shallow subtidal benthos is structured by emergent plants, specifically eelgrass in the GOA. These eelgrass beds perform ecological functions similar to those of macrophyte-dominated rocky shores, namely nursery functions, phytal habitat roles, feeding grounds, and sources of primary production (Jewett et al. 1999). In the vegetated habitats of the shallow subtidal zone, the demersal fish assemblage is typically more diverse than and quite different from the demersal fishes of the deeper subtidal zone (Hood and Zimmerman 1986). In eelgrass (*Zostera*) beds as well as in the beds of small kelps and other macrophytes (*Agarum, Nereocystis* and *Laminaria*) in the GOA, juveniles of many species that live in deeper waters as adults use this environment as a nursery for their young because of high production of food materials and protection from predators afforded by the shielding vegetation (Dean et al. 2000). Furthermore, several fishes are associated with the plant habitat itself, including especially pickers that consume crustaceans and other invertebrates from plant surfaces, a niche that is unavailable in the absence of the vegetation. Both types of vegetated habitats in the shallow subtidal zone of the GOA contain larger predatory invertebrates, specifically seastars and crabs. I some cases, the same species occupy both eelgrass and kelp habitats (Dean et al. 1996b).

Microbial decomposers play an extremely significant role in both shallow and deep subtidal sedimentary habitats of the sea (Braddock et al. 1996). Fungi and especially bacteria become associated with particulate organic matter and degrade the organic compounds. This decomposition process releases the nutrients such as phosphorus and nitrogen in a form that can be reused by plants when the water mass is ultimately recycled into the photic zone. In short, benthic decomposers of the subtidal seafloor play a necessary role in the nutrient cycling upon which sustained production of the sea depends. In addition, these decomposers themselves represent the foods for many deposit-feeding invertebrates of the subtidal seafloor. Much of the detritus that reaches the seafloor is composed of relatively refractive organic compounds that are not readily assimilated in the guts of animal consumers. The growth of microbial decomposers on this detritus acts to convert these materials into more utilizable nitrogen-rich biomass, namely fungi and especially bacteria. Bacteria also scavenge dissolved organic materials and repackage them into particulate bacterial biomass, which is then available for use in consumer food chains.

In the subtidal habitats, the benthic invertebrates serve as the prey for mobile epibenthic invertebrates and for demersal fishes (Hood and Zimmerman 1986, Jewett and Feder 1982). Mobile epibenthic invertebrates are distinguished from the benthos itself by their greater mobility and their only partial association with the seafloor. The vast majority of this group is composed of crustaceans, namely crabs, shrimps, tanaids, and some larger amphipods (Armstrong et al. 1995, Orensanz et al. 1998). In the GOA, this group includes Dungeness crabs; king crabs; snow crabs; Tanner crabs; both *Crangon* and *Pandalus* shrimps, such as spot shrimp, coon-striped shrimp, pink shrimp, and gray shrimp; and other shellfish resources that had great commercial importance before the climatic phase shift of the mid 1970s (Anderson and Piatt 1999, Mueter and Norcross 1999, Mueter and Norcross 2000). Climate and physical oceanography have the potential to exert important influences on recruitment and year-class strength of subtidal fishery stocks in the GOA (Zheng and Kruse 2000b), but the mechanisms and processes are poorly understood. Demersal fishes are those fishes closely associated with the seafloor, including flounders, halibut, sole, rockfishes, Pacific Ocean perch, and gadiids like cod and walleye pollock. They feed predominantly on the epibenthic invertebrates–the shrimps, crabs, and amphipods–but in addition prey directly on some sessile benthic invertebrates as well. Juvenile flatfish feed heavily by cropping (partial predation) on exposed siphons of clams and exposed palps of polychaetes. This role of provision of benthic invertebrate prey for demersal crustaceans and fishes is an important ecosystem service of the shallow subtidal seafloor.

The shift in the late 1970s from crabs and shrimps to dominance by demersal fishes associated with the shift in climatic regime implies a strong role for environmental forcing of community composition in this shallow subtidal system, although mechanisms of change dynamics are not understood (NRC 1996). Because of the effects of trawling on biogenic habitat, such as sponges and erect bryozoans, in subtidal soft sediments and the potential for fisheries exploitation to modify abundances of both targeted stocks and species caught as by-catch (Dayton et al. 1995), fishery impacts to the soft-bottom benthic community are a possible driver of community change. Because the demersal fishes that are taken by trawl and other fisheries represent the prey of threatened and endangered marine mammals such as Steller sea lions, the possible implications of fishing impacts to this community are important (NRC 1996).

The benthic invertebrate community of shallow unvegetated subtidal sediments has served worldwide as an indicator system for the biological influence of marine pollution. The infaunal invertebrates that compose this bottom community are sessile or slow-moving. They are diverse, composed of many phyla and taxa with diverse responses to the suite of potential pollutants that deposit upon the sedimentary seafloor. Consequently, this system is an ideal choice to monitor and test effects of marine pollution (Warwick 1993). The subtidal benthic community on the sedimentary seafloor is limited by food supply. Consequently, community abundance and biomass reflect the effects of organic enrichment. This is evident from variation in biomass among subtidal benthic communities geographically within the GOA (Feder and Jewett 1986). Therefore, changes in primary productivity in the water column above, allocation of that production between zooplanktonic herbivores and benthic invertebrates, and physical transport regimes combine to cause spatially explicit modification of soft-sediment benthic communities in unvegetated subtidal sediments that can serve to monitor ecosystem status. Furthermore, the taxonomic composition of soft-sediment benthic communities responds differentially to organic loading and toxic pollution (Warwick and Clarke 1993, Peterson et al. 1996), thereby rendering this system an excellent choice for monitoring to test among alternative drivers of ecosystem change. Among common invertebrate taxa of subtidal sedimentary habitats, the echinoderms and crustaceans (especially amphipods) are highly sensitive to toxic accumulation of heavy metals, PAHs, and synthetic organic compounds. Other taxa such as polychaetes include many opportunistic species that bloom with loading with organic pollutants, thereby allowing inferences about causation of anthropogenic responses (Peterson et al. 1996). This capability of subtidal benthic communities in soft sediments may prove useful in testing among alternative explanations for ecosystem change in the GOA.

The deeper subtidal habitats on the outer continental shelf and the continental slope are not well studied in the GOA system (Bakus 1978, SAI 1980a, SAI 1980b). There has been some description of the mobile epibenthic communities and the demersal fish communities of these deeper benthic habitats (Feder and Jewett 1986). Most sampling of these deeper benthic habitats involves trawling and focuses on the stocks of crabs, shrimps, and demersal fishes that are commercially exploited (Rosenberg 1972, Bakus 1978). The continental shelf as a whole (shallow to deep) represents a key fishing grounds in the GOA and has correspondingly high value to humans. Because community structure of benthic systems can be modified dramatically by the physical damage done by trawls to biogenic habitat such as sponges and soft corals (Dayton et al. 1995), this human activity is the object of concern. The continental slope, on the other hand, does not experience great fishing pressure.

3.7.3 General Research Questions

How do the substrates, bathymetry, physical factors, biological forces such as predation and competition, and human activities act together to define community structure?

What controls the rates of recruitment of key plant and animal species to the nearshore benthic communities?

- To what degree do recruitment processes control community structure and population abundances in intertidal-subtidal benthic systems?
- How does predation limit the abundance, diversity, and size composition of benthic marine invertebrates

What is the relationship between biological production processes and physical transport phenomena in the coastal ocean and settlement patterns and intensities of various species in intertidal-subtidal benthic communities?

How do biological interactions, both direct (such as predation and interference competition), and indirect (such as trophic cascades), influence the dynamics of community change and successional recovery from disturbance in intertidal-subtidal systems?

How does intertidal and subtidal habitat change influence species of fish, seabirds, and marine mammals from this and the other systems?

- How do offshore, ACC, and watershed processes influence the abundance, production, and dynamics of inter-tidal and subtidal species such as fishes, seabirds, and marine mammals?
- How do intertidal and subtidal habitats influence the abundance, production, and dynamics of species such as fishes, seabirds, and marine mammals in the offshore, ACC and watershed habitats?
- What are the relative contributions of carbon fixed by microalgae and macroalgae in the intertidal and subtidal?

What are the approaches to measuring community structure that allow the effects of human activities to be distinguished from the effects of natural forces in the intertidal and subtidal?

To what degree do human activities, such as watershed modifications, POP (POP stands for?) releases, organic loading, and direct and indirect effects of exploitation of marine resources, have important impacts on intertidal-subtidal benthic communities on rocky shores and in sedimentary habitats?

What is the degree to which toxins ingested by benthic invertebrates are transferred up the food chain in a form that can affect reproduction, growth, or survival of vertebrate consumers of those benthic prey?

What is the functional significance of biodiversity and apparent functional redundancy of the diverse suite of component species of intertidal/subtidal communities?

3.8 Forage Species

3.8.1 Definition

Forage species include a broad suite of species that are commonly consumed by higher trophic level species (fish, seabirds, and marine mammals). Specifies included in the forage species complex varies among authors and management agencies. The North Pacific Fisheries Management Council (NPFMC) groundfish fisheries management plan defines the forage species complex as a group of species that includes the following (NMFS 2001):

- Smelts (capelin, rainbow smelt, eulachon, and family Osmeridae);
- Pacific sand lance (*Ammodytes hexapterus*);
- Lantern fishes (family Myctophidae);
- Deep-sea smelts (family Bathylagidae);
- Pacific sandfish (*Trichòdon trichodon*);
- Euphausiids (*Thysanopoda, Euphausia, Thysanoesssa, and Stylocheiron*);
- Gunnels (family Pholidae);
- Pricklebacks (family Stichaeidae);
- Bristlemouths, lightfishes, and anglemouths.

Springer and Speckman (1997) extend this definition to include juvenile stages of commercially exploited species such as Pacific herring (*Clupea pallasi*), walleye pollock (*Theragra chalcogramma*), and Pacific salmon (*Oncorhynchus* sp.). For the purposes of this background review, the GEM program focuses on a subset of species that are commonly found in coastal or oceanic regions of the GEM study region. In the shelf environment, this subset includes euphausiids, capelin, eulachon, sand lance, juvenile pollock, juvenile herring and juvenile pink salmon (*Oncorhynchus gorbuscha)*. In the offshore environment, this subset includes common myctophids, such as small-finned lantern fishes (*Stenobrachius leucopsarus* and *Diaphus theta*), and bathylagids, such as the northern smoothtounge (*Leuroglossus schmidti*). This partitioning allows GEM to highlight several key research questions that could be the focus of future GEM programs.

A more complete description of the life history characteristics of the forage species identified by the GEM program can be found in Hart (1973, NMFS 2001). Table 3.1 summarizes key features of the life history characteristics.

3.8.2 Resource Exploitation in the GEM Region

Small amounts of non-commercial forage species are taken as bycatch in federal and state fisheries in the GOA (NPFMC 2000, NMFS 2001). In an attempt to discourage the development of target fisheries for forage species, the NPFMC restricts the catch of forage species to no more than 2% of the total landed catch of commercial fisheries in federal waters (NMFS 2001). Although the bycatch of non-commercial forage species tends to be low relative to target fisheries for commercially exploited species, the percentage of the bycatch relative to regional abundances of individual forage species is often not known because of the difficulty involved in assessing these species.

Pacific salmon fisheries off the coast of Alaska are managed by a complex system of treaties, regulations, and international agreements. State and federal agencies cooperate in managing salmon resources. The State of Alaska regulates commercial fisheries for salmon within state waters where the majority of the catch occurs. Federal agencies control the bycatch of juvenile salmon in groundfish fisheries through prohibited-species bycatch restrictions (NMFS 2001). In the GEM study region, pink salmon are primarily harvested by purse seines. Most of the pink salmon taken in PWS are of hatchery origin.

State and federal agencies also cooperate in managing Pacific herring fisheries. Most of the directed herring removals occur within state waters and are regulated by ADF&G. In federal waters, the removals of Pacific herring in groundfish fisheries are regulated through prohibited-species bycatch restrictions (NMFS 2001)

State and federal agencies regulate commercial removals of walleye Pollock. The majority of the catch occurs in federal waters; however, small state fisheries have started in PWS. In federal waters, the catch is regulated by federal agencies based on recommended harvest regulations provided by the NPFMC. The catch of juvenile pollock is assessed within the stock assessment and fisheries evaluation (SAFE) reports. Juvenile pollock catch is included in considerations regarding annual quotas for this species. The lack of a market for juvenile pollock less than 30 centimeters (cm) in length serves as an incentive to industry to minimize the bycatch of juvenile pollock. Efforts to minimize bycatch of juvenile pollock in pollock target fisheries include the voluntary adoption of alternative mesh configurations designed to reduce the retention of small pollock (Erickson et al. 1999).

3.8.3 Assessment Methods and Challenges

There are several impediments to the development of forage species assessments. The diversity of life history characteristics confound efforts to develop a multipurpose survey to assess forage species as a single complex. In addition, several forage species are small and pelagic, making them less vulnerable to the standard trawl gear used in broad-scale surveys to assess stocks conducted by ADF&G or NMFS. A high priority should be placed on research designed to overcome these impediments.

Several authors have reported on possible trends in forage species abundance in the shelf and offshore environment (Hay et al. 1997, Anderson and Piatt 1999, Blackburn and Anderson 1997, Beamish et al. 1999a). These papers rely on anecdotal information from surveys that were designed to assess the abundance of another species (such as shrimp, salmon, crab, or groundfish). Indices of abundance based on these data may be subject to error because of problems with the selectivity of the gear or the limited spatial or temporal scope of the surveys.

An assessment designed for forage species is needed to develop an accurate evaluation of the distribution and abundance of this important group of species. It is unlikely that a single survey would be adequate for all forage species; therefore, a variety of survey methods should be considered. Potential survey methods for forage species are identified in Table 3.2.

Table 3.1 Summary of Key Life History Characteristics of Selected Forage Species

Characteristics	Euphausiids: 11 species	Capelin *Mallotus villasus*	Eulachon *Thaleichthyes pacificus*	Pacific sand lance *Ammodytes hexapterus*	Walleye Pollock *Theragra chalcogramma*	Pacific herring *Clupea pallasii*	Pink salmon *Oncorhynchus gorbuscha*	Northern lanternfish *Stenobrachius leucopsarus*
Maximum age (years)	2	4	5	3	21	18	2	6
Maximum length (centimeters)	4	25	25	15	80	45	65	9
Prey	planktivorous	planktivorous	planktivorous	planktivorous	plankton and fish	planktivorous	plankton and fish	planktivorous
Peak spawning	spring	spring	spring	winter	winter-spring	winter-spring	summer	unknown–winter?
Spawn location	unknown	intertidal	rivers	late fall, early winter	pelagic on shelf	nearshore	rivers	unknown
Abundance trend	unknown (uncertain)	low stable (uncertain)	low stable (uncertain)	unknown	low stable	low	high stable	unknown
Foraging habitat	pelagic–mid-water over shelf	pelagic–mid-water over shelf	pelagic–mid-water over shelf	demersal–0-100 m	mesopelagic–demersal and over shelf	pelagic shelf	pelagic shelf and open ocean	mesopelagic–outer shelf and open ocean

Table 3.2 Potential Surveys for Assessment of Selected Forage Species

Type	Candidate Species
Small mesh mid-water surveys	Euphausiids, capelin, eulachon, juvenile pollock (age 0 and age 1), juvenile herring, small finned lanternfishes, northern smoothtongue
High-speed near-surface trawls	Juvenile salmon
Acoustic mid-water trawl surveys	Capelin, eulachon, juvenile pollock, juvenile herring, euphausiids
Small-mesh beach seines	Sand lance
Aerial spawning surveys	Pacific herring and capelin
Light detection and ranging (LIDAR)	Useful for species within the upper 50 m
Monitoring diets of key bird predators	Juvenile pollock, capelin and sand lance

3.8.4 Hypotheses About Factors Influencing Food Production for Forage Fish Production

Several hypotheses (summarized below) have been advanced to explain trends in forage fish distribution and abundance. For the most part, these hypotheses are based on research in the shelf and coastal waters of the western central GOA ecosystem, including PWS. Detailed process-oriented research has been conducted to confirm hypotheses for a small number of forage species, and these studies were often conducted in a limited geographic area representing only a fraction of the range of the species.

1. Feeding opportunities for early feeding larvae: Shifts in large-scale atmospheric forcing controls the structure of marine fish communities in the western central GOA ecosystem through its role in determining the timing of peak production. Species that spawn in the winter and early spring will be favored by periods of early peak production, while species that spawn in the late spring and summer will be favored by periods of delayed production (Mackas et al. 1998, Anderson and Piatt 1999).

2. Concentration of prey for early feeding larvae: Ocean conditions that favor concentration of forage fish and their prey will enhance production of forage species. The FOCI program identified a potential mechanism linking increased precipitation to enhanced eddy formation and reduced larval mortality. Eddies are believed to provide a favorable environment for pollock larvae by increasing the probability of encounters between larvae and their prey (Megrey et al. 1996). Research is needed to determine whether this mechanism may be important for other forage fishes within the western and central GOA.

3. Prey dispersal for early feeding larvae: An inverse or dome-shaped relationship exists between the amount of wind mixing and forage fish production. Bailey and Macklin (1995b) compared hatch date distributions

of larval pollock with daily wind mixing. This analysis showed that first-feeding larvae exhibited higher survival during periods of low wind mixing. Megrey et al. (1996) speculated that extremes in wind mixing would result in reduced pollock survival because low-wind mixing would reduce the availability of nutrients in the mixed layer and high-wind mixing would lead to reduced encounters between pollock and their prey.

4. Competition for prey: At finer spatial scales, prey resources for forage fish may be limited, leading to resource partitioning to minimize competition between forage fish species that occupy similar habitats. Willette et al. (1997) examined the diets of juvenile walleye pollock, Pacific herring, pink salmon, and chum salmon in PWS. Their study revealed that two species pairs (walleye pollock and Pacific herring, and pink and chum salmon) exhibited a high degree of dietary overlap. This finding suggests that in PWS, competition for food resources may occur within these pairs when food abundance is limited. Purcell and Sturdevant (2001) found evidence of potential competition between zooplantivorous jellyfish and juvenile fishes in PWS. Their study showed high diet overlaps in the diets of pelagic coelenterates and forage species and that these species co-occur spatially and temporally in PWS.

5. Prey utilization: Overwintering mortality of forage species is dependent on the amount of energy accumulated during the summer. Field and laboratory experiments suggest that the overwintering success of both age-0 Pacific herring and age-0 walleye pollock may be dependent on the amount of energy accumulated during summer (Foy and Paul 1999, Sogard and Olla in press). However, the early life history strategy of walleye pollock may make them less susceptible to starvation during the winter period. Paul and Paul (1999) compared the growh strategies of larval and age-0 walleye pollock and Pacific herring. This comparison revealed that walleye pollock metamorphose early, allowing for an extended growth period, while Pacific herring metamorphose later and accumulate energy for overwintering. Rapid growth provides increased swimming speed leading to more successful prey capture and predator avoidance. The benefits of the pollock strategy may allow them to continue to grow through the winter (Paul et al. 1998).

3.8.4.1 Food Quality

Efforts to improve understanding of the mechanisms underlying the production of forage species would benefit from an improved understanding of the principal prey utilized by forage species. Although detailed information exists for commercial species such as juvenile pollock, salmon, and herring (Cianelli and Brodeur 1997, Willette et al. 1997), only limited information is available to describe the prey preferences of many members of the forage fish complex. In particular, information is lacking in the case of offshore species.

3.8.5 Hypotheses About Predation on Forage Fish

By definition, forage species represent an important prey resource for many higher-trophic-level consumers (fish, seabirds, and marine mammals). Top-down predation pressure on forage fish depends on several factors, including predator abundance, the abundance of alternative prey, the density of prey, and the patchiness of prey. Changes in these factors will influence the relative importance of top trophic-level forcing on forage fish production.

Evidence suggests that in some years, fish predation may exhibit a measurable effect on forage species production in the GEM region. Anderson and Piatt (1999) noted that the post regime shift increase in gadoid and pleuronectid fishes coincided with marked declines in capelin and shrimp populations. They proposed that this inverse relationship could be caused by increased predation mortality due to an increase in picivorous (fish-eating) species. Consistent with this hypothesis, Bailey (2000) performed a retrospective analysis of factors influencing juvenile pollock survival. He provided evidence that during the 1980s, pollock populations were largely influenced by environmental conditions, and after the mid-1980s, juvenile mortality was higher, resulting from the buildup of large fish predator populations. In PWS, Cooney (1993) speculated that pollock predation could explain some of the observed trends in juvenile salmon survival. He suggested that years of high copepod abundance were associated with high juvenile salmon survival, because pollock relied on an alternative prey resource. In the open ocean, Beamish et al. (1999a) proposed that mesopelagic fishes transfer and redistribute energy through two primary trophic pathways: (1) abundant zooplankton to *S. leucopsarsus* and then squid, and (2) *S. leucopsarsus*, *D. theta*, and *L. schmidti* to walleye pollock, salmon, dolphin, and whales. The division of energy through these pathways is thought to influence the amount of energy reaching the sea floor.

The importance of forage fish in seabird and marine mammal diets has been demonstrated by a number of authors (Hatch and Sanger 1992, Springer et al. 1996, Kuletz et al. 1997, Ostrand et al. 1998). There is little evidence that seabird predation is sufficient to regulate the production of forage fishes in the GEM region, however. Note to author: Recent anecdotal evidence published in Nature (Thomas and Thorne) circumstantially links predation by sea lions and seabirds to control of herring populations in PWS. Growth in humpback whale populations may not be inconsequential with respect to control of small herring populations. This does not change the conclusion of this paragraph, but perhaps should be mentioned. Therefore, key research elements for predation of forage species by marine mammals and seabirds should focus on the role of oceanographic features in concentrating forage species within the foraging range of seabirds and marine mammals.

While only a few studies have examined the importance of gradients (fronts) or water mass characteristics in aggregating forage species for top predators in the GEM region, the importance of these features is well known in other regions. In the Atlantic, aggregations of capelin appear to be associated with strong thermal fronts (Marchland et al. 1999). Likewise, climate impacts on the distribution and productivity of Antarctic krill (*Euphausia seperba*) have been shown to produce important impacts on higher trophic level consumers (Reid and Croxall 2001, Loeb 1997). Hay et al. (1997) found that, in warm years, eulachon off the coast of British Columbia were more abundant in the offshore environment, while in cool years, eulachon were more common in the nearshore environment. Consistent with the hypothesis of Hay et al., Carscadden and Nakashima (1997) noted a marked decline in offshore capelin abundance during a cool period in 1990s in the Atlantic.

3.8.6 Hypotheses Concerning Contamination

Because of the broad distribution and abundance of contaminants, there is little evidence to suggest that contaminants regulate the production of forage species in Alaska waters. If forage species exhibit subpopulation genetic structure, contaminants could be influential in the local mortality rate of forage fish subpopulations. The small size, short life span, and importance as a prey item for higher trophic level foragers make forage species ideal indicators of regional contaminant levels (Yeardley 2000). For example, Roger et al. (1990) noted that the high lipid content of eulachons suggests that they may be potential integrators of low-level contaminants. If forage species are to be used as a regional indicator of ecosystem conditions, research is needed to determine whether forage species bioaccumulate toxic chemicals. Studies are needed to determine whether observed accumulations of toxic chemicals are sufficient to change mortality rage of forage species. If forage species accumulate lethal levels of toxic chemicals at the regional level, genetic studies are needed to determine whether these populations represent genetically unique subpopulation segments.

3.8.7 General Research Questions

How can trends in abundance of forage species be explained?

- What is the role of large-scale atmospheric forcing in controlling the structure of marine fish communities in the western central GOA ecosystem?
- Are species that spawn in the winter favored by periods of early peak primary production, and species that spawn in the spring and summer favored by periods of delayed production?

Do ocean conditions that favor concentration of forage fish and their prey enhance production of forage species?

- Do eddies favor enhanced production and recruitment of forage species?

Is the amount of wind mixing inversely or directly (for example, Rothschild-Osborn) proportional to forage fish production?

Does interspecific competition at small spatial scales limit production of forage fish species that occupy similar habitats?

Does predation limit the abundance of forage species populations?

Does the aggregation of forage species by gradients (fronts) or water mass characteristics allow top predators to control forage species abundance in the ACC and offshore?

What is the role of food quality as shown by prey preference selection in controlling forage species abundance?

What is the role of accumulations of toxic chemicals in forage species in influencing reproduction, growth, and death of forage species?

3.9 Seabirds

3.9.1 Overview

The GOA supports huge numbers of resident seabirds: 26 species nest around the periphery of the GOA, with an estimated total on the order of 8 million birds (Table 3.3). Note to author: Are sea ducks not considered seabirds? Seaducks should be included somewhere, since they are important members of shallow marine communities. Most species are colonial and aggregate during summer at about 800 colonies. A variety of habitats are used for nesting, such as cliff faces, boulder and talus fields, crevices, and burrows in soft soil. Two species, Kittlitz's and marbled murrelets, are not colonial and nest in very atypical habitats. Kittlitz's murrelets nest on scree fields in high alpine regions often many kilometers from the coast, and marbled murrelets nest mainly in mature trees in old-growth conifer forests, also often distant from the coast.

Table 3.3 Nesting Seabirds in the Gulf of Alaska

English Name	Scientific Name	Abundance[1] (thousands)	Biomass[2] (tonnes)	Nesting Habitat[3]	Foraging Mode[4]
Northern fulmar	*Fulmarus glacialis*	440	268	Cliff	SF
Fork-tailed storm-petrel	*Oceanodroma furcata*	640	32	Burrow	SF
Leach's storm-petrel	*Oceanodroma leucorhoa*	1,067	53	Burrow	SF
Double-crested cormorant	*Phalacrocorax auritus*	3.3	6	Cliff	CD
Brandt's cormorant	*Phalacrocorax penicillatus*	0.086	0.2	Cliff	CD
Pelagic cormorant	*Phalacrocorax pelagicus*	21	40	Cliff	CD
Red-faced cormorant	*Phalacrocorax urile*	20	38	Cliff	CD
Unidentified cormorant	*Phalacrocorax* spp.	15	29	Cliff	CD
Mew gull	*Larus canus*	15	11	Ground	SF
Herring gull	*Larus argentatus*	1	1	Ground	SF, S
Glaucous-winged gull	*Larus glauscescens*	185	241	Ground	SF, S
Black-legged kittiwake	*Rissa tridactyla*	675	270	Cliff	SF
Arctic tern	*Sterna paradisaea*	8.9	1.2	Ground	SF
Aleutian tern	*Sterna aleutica*	9.4	1.2	Ground	SF
Unidentified tern	*Sterna spp.*	1.7	0.22	Ground	SF
Common murre	*Uria aalge*	589	589	Cliff	DD
Thick-billed murre	*Uria lomvia*	55	55	Cliff	DD
Unidentified murre[5]	*Uria spp.*	1,197	1,197	Cliff	DD
Pigeon guillemot	*Cepphus columba*	24	13	Crevice	CD
Marbled murrelet	*Brachyramphus marmoratus*	200	48	Tree	CD
Kittlitz's murrelet	*Brachyramphus brevirostris*	+	+	Scree	CD
Ancient murrelet	*Synthliboramphus antiquum*	164	38	Burrow	CD
Cassin's auklet	*Ptychoramphus aleuticus*	355	71	Burrow	DD
Parakeet auklet	*Cerorhinca monocerata*	58	17	Crevice	DD
Least auklet	*Aethia pusilla*	0.02	0.0018	Talus	DD
Crested auklet	*Aethia cristatella*	46	14	Talus	DD
Rhinoceros auklet	*Cyclorrhynchus psittacula*	170	90	Burrow	DD
Tufted puffin	*Lunda cirrhata*	1,093	874	Burrow	DD
Horned puffin	*Fratercula corniculata*	773	425	Crevice	DD
Total		**7,826**	**4,423**		

[1]From U.S. Fish and Wildlife Service (USFWS), seabird colony database: marbled murrelet in Gulf of Alaska from Piatt and Ford (1993).

[2]Based on weights of seabirds presented by DeGange and Sanger (1986).

[3]Principal type

[4]SF = surface-feeder; CD = coastal diver; DD = deep diver; S = scavenger. From DeGange and Sanger (1986).

[5]Essentially all common murres.

Predation by terrestrial mammals and rapacious birds undoubtedly is responsible for the nesting habitats and habits adopted by seabirds. Cliff-nesting species are free to nest on mainland sites, because mammals cannot reach them and they are large enough to defend themselves and their nests against most avian predators. Ground-nesting species do not have this option and must nest only on islands free from predatory mammals. Additionally, some ground-nesting species come and go to and from colonies only at night, apparently to further thwart avian predators.

Foxes, rats, voles, and ground squirrels were variously introduced to most islands in the Aleutians and GOA between the late 1700s and early 1900s and severely reduced the abundances of many species of ground-nesting seabirds, such as storm-petrels, auklets, murrelets, and puffins (Bailey and Kaiser 1993, Boersma and Groom 1993, Springer et al. 1993). Today, even though foxes no longer exist on most islands, numbers of these species of ground-nesting seabirds still likely reflect the effects of introduced mammals. Moreover, predators that occur naturally occasionally have large, local effects on nesting seabirds in the GOA (Oakley and Kuletz 1996, Seiser 2000).

The distribution and abundance of nesting seabirds in the GOA is therefore governed primarily by the availability of suitable, safe nesting habitats, as well as by the availability of prey. For example, cliff-nesting species, such as murres and kittiwakes, require cliffs facing the sea. Therefore, regardless of the biomass of potential forage species in the eastern GOA, there are no murres or kittiwakes in much of the region because of the lack of sea cliffs. Where suitable nesting habitat does exist, seabirds nearly always occupy it, and fluctuations in their productivity and abundance through time are thought to be determined for the most part by fluctuations in prey populations.

Species that nest on cliff faces, such as murres and kittiwakes, are the most well-studied because of their visibility. Completing censuses of cliff-nesting seabirds is comparatively easy, as is measuring several components of their breeding biology, including the study of recurring natural phenomena such as migration (phenology) and reproductive success. Consequently, precise estimates of abundance and productivity, and trends in these variables through time, are available for murres and kittiwakes at many colonies in the GOA. In addition to their visibility, murres and kittiwakes are extremely numerous and widely-distributed, and more is known about them than about any other species.

In contrast, seabirds that nest underground are difficult to study. A further complication is that some of these are nocturnal as well. Despite huge numbers and broad distributions of some diurnal species, such as puffins, and nocturnal species, such as storm-petrels, much less is known about population sizes and productivity or trends in these parameters through time and space. They do have scientific value, however, because other characteristics of their biology offer valuable opportunities for obtaining information on the distribution and dynamics of prey populations important to a variety of seabirds and marine mammals.

Most seabirds in the GOA are primarily piscivorous (fish eating) during the nesting season. The principal exceptions include northern fulmars, storm-petrels, and thick-billed murres, which consume large amounts of squid; auklets, which specialize on zooplankton; and gulls, terns, and guillemots, which consume considerable amounts of crustaceans in addition to fish. Many species of fishes are taken, although a comparatively small number contribute the bulk of the biomass to diets of most seabirds. Overall, the three most important species of fishes are sand lance, capelin, and pollock. At certain colonies, at certain times, in certain years, or any combination of these conditions, the myctophids, Pacific cod, saffron cod, herring, sablefish, pricklebacks, prowfish, and salmon are also important to some species (Hatch 1984, Baird and Gould 1986, DeGange and Sanger 1986, Sanger 1987, Hatch and Sanger 1992, Irons 1992, Piatt and Anderson 1996, Suryan et al. 2000, Gill and Hatch unpublished data).

Resident GOA seabirds can be divided into three groups based on their foraging behavior (Table 3.3). Surface-feeders, as their name implies, obtain all of their food from about the upper 1 m of the water column and often forage over broad areas. Coastal divers can generally reach bottom and typically forage in shallow water near shore. Pelagic mid-water and deep divers are capable of exploiting prey at depths of up to nearly 200 m and of foraging over large areas (Schneider and Hunt 1982, Piatt and Nettleship 1985). Most individuals of most species forage over the continental shelf during summer. This is due primarily to the location of nesting areas, which are along the mainland coast and on nearshore islands, and the distribution of forage species, which in aggregate are more diverse and abundant on the shelf than off the shelf. Exceptions to this generalization are the fulmars and storm-petrels, which have anatomical, behavioral, and physiological adaptations that allow them to forage at great distances from their nesting areas, giving them access to resources off the shelf (Boersma and Groom 1993, Hatch 1993); and species such as kittiwakes that typically feed over the shelf, but which can efficiently exploit prey off the shelf when those prey are within foraging range from their nesting locations (Hunt et al. 1981, Springer et al. 1996, Hatch unpublished data).

Characteristics such as broad sampling of forage populations and sensitivity to prey availability make seabirds valuable tools in the study of marine ecosystems.

Therefore, as a group, seabirds sample forage populations broadly in three dimensions. These characteristics, plus variations in diet between species and the sensitivity of various components of their breeding biology and population abundance to fluctuations in prey availability, make seabirds in the GOA, as elsewhere, valuable tools in the study of marine ecosystems (Cairns 1987, Aebischer et al. 1990, Furness and Nettleship 1991, Springer 1991, Hatch and Sanger 1992, Montevecchi and Myers 1996, Piatt and Anderson 1996, Springer et al. 1996).

Seabird populations in the North Pacific from California to Arctic Alaska are very dynamic, waxing and waning in response to changes in prey abundance, predators, entanglement in fishing gear, and oil spills (Anderson et al. 1980, Ainley and Broekelheid 1990, Paine et al. 1990, Murphy et al. 1991, Hatch 1993, Hatch et al. 1993, Ainley et al. 1994, Byrd et al. 1998, Divoky 1998). Oil spilled from the *Exxon Valdez* killed an estimated 250,000 seabirds in the GOA, 185,000 of which were murres (Piatt and Ford 1996). Most murre mortality occurred downstream from PWS near the Barren Islands and Alaska Peninsula and had an unknown effect on the abundance of murres at regional colonies. There is evidence that the immediate mortality and lingering effects of the spill in PWS have depressed the abundance of several other species of seabirds there throughout the 1990s (Irons et al. 2000).

A strong case also has been made for a broad-scale decline in seabird abundance in the GOA during the past 2 to 3 decades beginning before the EVOS. Marine birds counted at sea in summer in PWS apparently declined by some 25% in aggregate between 1972 and the early 1990s (Kuletz et al. 1997). Many species contributed to the decline, including loons, cormorants (-95%), mergansers, Bonaparte's gulls, glaucous-winged gulls (-69%), black-legged kittiwakes (-57%), arctic terns, pigeon guillemots (-75%), marbled and Kittlitz's murrelets (-68%), parakeet auklets, tufted puffins, and horned puffins (-65%) (Klosiewski and Laing 1994). Other census data further indicated that for the marbled murrelet, at-sea winter abundance declined by more than 50% throughout the GOA during this time (Piatt and Naslund 1994). Results from studies at several murre colonies in the GOA in summer tend to support this pattern. Piatt and Anderson (1996) reviewed the abundance histories of 16 colonies and concluded that many were in decline before the EVOS. Therefore, it proved difficult to estimate the effect oil had on murre populations.

It is generally thought that alterations in forage fish abundance and community structure brought on by environmental change not associated with the oil spill, such as climate change, have been primarily responsible for falling seabird populations (Oakley and Kuletz 1996, Piatt and Anderson 1996, Hayes and Kuletz 1997, Kuletz et al. 1997, Anderson and Piatt 1999). For example, pigeon guillemot numbers in PWS in 1978 to 1980 averaged about 40% higher than in the early 1990s, and they declined further through 1996 (Oakley and Kuletz 1996). The decline in abundance was accompanied by a decline in the occurrence of sand lance in their diets, and it has been suggested that cause and effect relate the two. Because sand lance has a much higher fat content than the forage species guillemots switched to, such as pollock and blennies, it is nutritionally superior (Anthony and Roby 1997, Van Pelt et al. 1997). In Kachemak Bay, sand lance was particularly abundant in diets of guillemots nesting in high-density colonies in the late-1990s, and chicks fed predominantly sand lance grew faster than chicks fed lower-quality prey (Prichard 1997). Likewise, reductions in energy-dense capelin in the GOA and in diets of several species of seabird in the 1980s compared to the 1970s also have been linked to population declines (Piatt and Anderson 1996, Anderson and Piatt 1999).

Additional evidence of possible climate-mediated population decline is the frequency and magnitude of large seabird die-offs in the past 2 decades. Some of these involved huge numbers of surface-feeding species in summer, particularly kittiwakes and shearwaters in the GOA and especially the Bering Sea, during years of strong El Niño events, notably 1983 and 1997 (Nysewander and Trapp 1984, Mendenhall 1997). Others involved principally murres in the GOA in winter. In 1993, on the order of 100,000 common murres starved to death, and in 1997, at least tens of thousands suffered a similar fate (Piatt and van Pelt 1993, Piatt unpublished data). Such acute mortality, when added to the normal, or perhaps elevated, attrition suffered by juvenile birds in recent years, could have significant repercussions on population size. As Piatt and Anderson (Piatt and Anderson 1996) note, there was only 1 reported die-off of seabirds in the general region before 1983, and that was in the Bering Sea in 1970 (Bailey and Davenport 1972).

There is no evidence that seabirds in the GOA have been directly affected by commercial fisheries. Most of the prey of seabirds are not targeted; for example, sand lance and capelin. Adults of some prey species are fished, such as pollock, Pacific cod, and herring, but most seabirds can feed only on the small age-0 and age-1 fish of these large types and therefore do not compete with commercial fisheries for biomass. Indirect effects of commercial fishing are possible if stock sizes are affected by fishing and if stock size influences the abundance of young age classes of those species or the abundance of other forage species.

3.9.2 Case Studies

A lot of information has been collected on seabirds in the GOA in the past 3 decades, although much of the data obtained in the last 10 years has not yet been published or even presented. Therefore, the integration of all results into a composite picture of seabird ecology is not currently possible. Nevertheless, good information is available for some aspects of the biology of certain species at certain sites, and these examples can be used to give a general idea of the status of seabirds and their sensitivity to change in the environment. Prominent species are the black-legged kittiwake and common murre. They are among the most abundant and widely distributed seabirds, nesting at hundreds of colonies from Southeastern Alaska to Unimak Pass. These attributes and their ease of study have made them the best known of all species in the GOA. Information on trends in abundance, productivity, and diets of kittiwakes and murres at several locations spans periods of 1 to more than 4 decades. Information on other species, notably fulmars and puffins, at some colonies provides additional context.

The black-legged kittiwake and common murre are the most abundant, most widely distributed, and best known bird species in the GOA.

3.9.2.1 Middleton Island

The longest time series of reliable abundance estimates for seabirds in the GOA comes from Middleton Island, where the first count was made in 1956 (Rausch 1958). Between 1956 and 1974, the number of kittiwakes increased by an order of magnitude, from about 14,000 to 144,000 birds (Baird and Gould 1986). That increase is thought to have been made possible by the 1964 earthquake, which uplifted large sections of Middleton Island and created extensive new nesting habitat. Numbers of kittiwakes remained high there throughout the 1970s, but began to decline steadily in the early 1980s from a peak of about 166,000 birds to about 16,000 today (Hatch et al. 1993, Hatch unpublished data).

The decline in abundance has been accompanied by generally low productivity since the early 1980s, averaging just 0.06 chicks per pair between 1983 and 1999 (Table 3.4). Supplemental feeding of kittiwakes in recent years altered a variety of adult breeding parameters sensitive to food supply and increased survival of chicks, strongly supporting the notion that food limitation has been the cause of poor productivity and population decline (Gill 1999, Gill and Hatch unpublished data).

The longest time series of abundance data for murres also comes from Middleton Island. As with kittiwakes, the murre population increased by about an order of magnitude following the 1964 earthquake, numbering 6,000 to 7,000 individuals by the mid-1970s. Also like kittiwakes, murre abundance at Middleton Island was in decline by the end of the decade, falling to about 4,000 individuals by 1985. The population abruptly increased the following year to nearly 8,000 birds, where it remained through 1988, rapidly declined again to about 2000 by 1992, and has been more or less stable since (Hatch unpublished data). The cause of the decline is thought to have been driven in part by the growth of vegetation that hampers access of chicks to the sea once they leave the nest (Hatch unpublished data), but the sharp increases and decreases during the course of the overall decline argues for other controlling factors.

Glaucous-winged gulls also probably nested in comparatively small numbers on Middleton Island before 1964, although no counts were made in the early years. By 1973 there were fewer than 1,000 individuals and fewer than 2,000 a decade later. However, in contrast to findings for murres and kittiwakes, the population ballooned to more than 12,000 birds between 1984 and 1993, and now totals about 11,000 (Hatch unpublished data). Predation by gulls on kittiwake and murre eggs and chicks may have contributed to the declines of those species (2001).

The abundance of rhinoceros auklets on Middleton Island more than doubled from about 1,800 to 4,100 burrows between 1978 and 1998 (Hatch unpublished data). Although there are no hard data, it seems likely that few or no rhinoceros auklets nested there before the earthquake because of a lack of habitat (Hatch unpublished data). Therefore, the increase in rhinoceros auklet abundance might be just the result of an increase in the extent of nesting habitat as vegetation covered uplifted soils. At St. Lazaria Island in Southeast Alaska, however, rhinoceros auklet numbers nearly doubled during the 1990s (Byrd et al. 1999), indicating that other factors are possibly involved.

Table 3.4 Trends in Kittiwake Abundance and Productivity at Colonies in the Gulf of Alaska

Colony(s)	Population Trajectory	Average Production, 1983-2000	Number of Colonies	Colony years
Gull Island[1]	Up	0.39	1	15
Prince William Sound[2]	Up	0.30	4	67
Barren Island[3]	Level	0.40	1	7
Prince William Sound–Overall[2]	Level	0.13	22	372
Prince William Sound[2]	Up-Down	0.14	5	94
Prince William Sound[2]	Level	0.15	2	34
Chiniak Bay[2]	Level	0.19	1	16
Semidi Islands[3, 4]	Down	0.05	1	11
Chisik Island[1]	Down	0.06	1	9
Prince William Sound[2]	Down	0.04	11	177
Middleton Island[4]	Down	0.06	1	?

[1]From J. Piatt (unpublished data)

[2]From D. Irons (unpublished data)

[3]From USFWS (unpublished data)

[4]From S. Hatch (unpublished data)

Table 3.4 needs to be explained fully by the author the first time it is cited in Section 3.9.2.1. Also the three groups in the table should be labeled using the blank lines above each group, and a distinction needs to be drawn among the four different PWS colonies and this distinction needs to be explained in Section 3.9.2.1 the first time the Table is cited. Alternatively, the table and its contents could be fully explained in the caption and table notes.

A lack of adequate data precludes firm conclusions about trends in abundance of tufted puffins, but it is thought that they are increasing in abundance on Middleton Island as well (Hatch unpublished data).

Pelagic cormorants are known to move between nesting areas within colonies between years; therefore, census data are not necessarily as accurate for them as for other cliff-nesting species of seabirds. The data show that numbers of nesting pairs were comparatively stable at about 2,000 to 2,800 between the mid-1970s and mid-1980s. The number of pairs was extremely volatile from 1985 to 1993, however, rising and falling by as much as 700% between consecutive years. In 1993, pelagic cormorants numbered about 800 pairs, and have increased steadily since then to about 1,600 pairs (Hatch unpublished data).

Seabirds at Middleton Island feed on a variety of forage species common throughout the GOA (Hatch 1984, Hatch and Gill unpublished data). Early in the nesting season kittiwakes typically prey on extremely energy-dense myctophids, which are generally restricted in their distribution to deep-water regions off continental shelves (Willis et al. 1988, Sobolevsky et al. 1996). Later they switch to other, likely more accessible, prey and feed chicks primarily on sand lance, although capelin and sablefish are also important in some years (Hatch and Gill unpublished data).

Rhinoceros auklets feed on numerous species of fishes, but seem to be sand lance specialists (Hatch 1984, Vermeer and Westrheim 1984, Vermeer et al. 1987). At Middleton Island, sand lance contributed on average 62% of the biomass fed to chicks in 11 years between 1978 and 2000 (Hatch unpublished data). In years of apparent low abundance during the first half of the 1990s, pink salmon, capelin, greenlings, and sablefish replaced sand lance.

Tufted puffins at Middleton Island feed their chicks predominantly sand lance in years when sand lance are most abundant: sand lance make up as much as 90% of biomass in peak years. Tufted puffins apparently switch to other prey sooner than rhinoceros auklets when sand lance is scarce. Alternative prey of tufted puffins consists mainly of pollock and prowfish, with somewhat lesser amounts of sablefish (Hatch unpublished data).

3.9.2.2 Prince William Sound

Twenty-three kittiwake colonies in PWS were first counted in 1972, but were not counted again until 1984. These and an additional six colonies have been visited nearly each year since (Irons 1996, Irons unpublished data). During this time, long-term increases and decreases have been noted at various colonies, but no obvious geographic pattern to the changes was found. Instead, four colonies have grown to large size, and numerous smaller colonies have declined, with some disappearing completely. Note to author: Are any of these colonies represented by the four colonies in Table 3.4? Several other colonies first increased, then decreased, and two have not changed appreciably. At least some of these changes likely resulted from movements of adults between sites (Irons unpublished data). For example, as the Icy Bay colony declined from about 2,400 birds in 1972 to fewer than 100 by 2000, the nearby North Icy Bay colony grew from about 500 birds in 1972 to about 2,000 by the late 1990s. Overall, the total abundance of kittiwakes in PWS has remained stable, or perhaps increased slightly, despite substantial interannual variability; for example, decreasing by 45% between 1991 and 1993 and increasing by 35% between 1999 and 2000.

Overall productivity likewise has been highly variable between years, but generally has been much greater than at Middleton Island, averaging 0.13 chicks per pair since 1984 (Table 3.4). Note to author: There are four values in Table 3.4 and they do not average 0.13. Average productivity differed considerably between colonies with different population trajectories, however (Table 3.4). The average productivity of four colonies with increasing populations was twice that of two stable colonies and five colonies that experienced matching increases and decreases, while productivity at those was nearly four times as great as that at 11 declining colonies.

3.9.2.3 Lower Cook Inlet

Kittiwakes at Chisik Island in Lower Cook Inlet were first counted in 1971 (Snarski 1971), and the population appears to have fallen steadily since then. By 1978, the number of birds was down by about 40% and today it is just 25% of the 1971 total (Piatt unpublished data). The trend in murre abundance at Chisik Island has paralleled that of kittiwakes, but the decline has been even steeper. The population fell by more than half between 1971 and 1978, and today stands at just about 10% of its former abundance. Kittiwake productivity has been poor in most years, averaging just 0.06 chicks per pair (Table 3.4). Less is known about productivity of murres, which has been estimated only since 1996. In that time, it has been variable and averaged 0.56 chicks per pair (Table 3.5).

Table 3.5 Trends in Murre Abundance and Productivity at Colonies in the Gulf of Alaska

Colony	Population Trajectory	Average Production, 1989-2000	Range	Colony years
Gull Island[1]	Up	0.52	0.28-0.65	4
Chisik Island[1]	Down	0.56	0.18-0.74	4
Barren Island[2]	Up	0.73	0.58-0.75	5
Semidi Islands[2, 3]	Up	0.48	0.21-0.58	6

[1]From J. Piatt (unpublished data)
[2]From USFWS (unpublished data)
[3]From S. Hatch (unpublished data)

In contrast, just across Cook Inlet at Gull Island in lower Kachemak Bay, numbers of kittiwakes and murres have increased substantially since counts were first made in 1976. The abundance of kittiwakes more than doubled between the mid-1970s and mid-1980s, peaked in 1988, and has averaged about 10% to 15% lower through the 1990s (Piatt unpublished data). The growth in numbers of murres was somewhat less abrupt, but more enduring, with steady, exponential growth of about 300% through 1999. Productivity of kittiwakes at Gull Island has been much higher than at Chisik Island, and has been among the highest anywhere in the GOA with comparable data (Table 3.4). Productivity of murres at Gull Island has been less variable than at Chisik Island, but has averaged essentially the same, 0.52 chick per adult (Table 3.5).

Kittiwakes were first counted on the Barren Islands, at the mouth of Cook Inlet, in 1977. The next counts in 1989 to 1991 were apparently comparable. Systematic counts began in 1993 and have continued since. It is not known if the earlier (1977 to 1991) and later (1993 to 1999) groups are comparable. Within-group data indicate that there was no apparent change in kittiwake abundance during either time period. Likewise, there are two groups of counts for murres—7 counts between 1975 and 1991 and 10 systematic counts between 1991 and 1999. Counts in the early part of the first interval are not comparable to later counts in that interval; therefore, it is not known whether murre numbers changed from the 1970s to the late 1980s. Since 1989, however, the population has steadily grown by about 40% (Roseneau unpublished data). Kittiwake productivity at the Barren Islands in the 1990s was as high as at Gull Island (Table 3.4). Murre productivity since 1995 has averaged 0.73 chick per pair, which is higher than at either of the other colonies in Lower Cook Inlet.

Kittiwakes and murres at all three locations prey on a similar suite of forage fishes, but the proportion of each species in diets varies depending on their relative abundance. Sand lance, capelin, and cods are the three most important taxa of prey (Piatt unpublished data, Roseneau unpublished data). Among the cods, the proportions of pollock, Pacific cod, and saffron cod vary by location. A variety of evidence from the Lower Cook Inlet region indicates that population trends of kittiwakes and murres at the three colonies are directly related to the abundance of prey available to the birds (Kitaysky et al. 1999, Robards et al. 1999, Piatt unpublished data, Roseneau unpublished data).

3.9.2.4 Kodiak Island

Of numerous seabird colonies on Kodiak Island, only the one at Chiniak Bay has received much attention. Kittiwakes were first counted there in 1975 to 1977 and numbers were stable. They were next counted in 1984, by which time the population had more than doubled. Numbers have since been variable, but showed no significant changes until 1999, when they were about twice as great as in 1997 to 1998. Kittiwake productivity at Chiniak Bay was very high for at least 2 years in the mid-1970s (about 1 chick per nest), but was poor in the 1980s, averaging just 0.11 chick per nest between 1983 and 1989. Productivity improved in the 1990s, averaging 0.24 chick per nest, and has averaged 0.19 chick per nest overall since 1983 (Table 3.4). This pattern of productivity contrasts with patterns seen in PWS and at Gull Island. Note to the author: There are four different PWS colonies in Table 3.4.

Kittiwakes at Chiniak Bay preyed primarily on sand lance and capelin in the 1970s. Variations in diet between years were correlated with variations in productivity (Baird 1990).

3.9.2.5 Semidi Islands

Approximately 2,500,000 seabirds, or about a third of all the seabirds nesting in the GOA, are found on the Semidi Islands, including about 10% of the kittiwakes, half of the murres and horned puffins, and nearly all of the northern fulmars (Hatch and Hatch 1983). Seabird studies on the Semidi Islands began in 1976 and have continued in most years since. Most work has occurred at Chowiet Island, which hosts on the order of 400,000 birds of at least 15 species, with the cliff-nesting species–kittiwakes, murres, and fulmars–receiving the greatest attention.

The number of kittiwakes at Chowiet Island varied little through 1981, although the number of nests grew by 60%. No counts were made in 1982 to 1988. Kittiwake abundance in 1989 and 1990 had not changed, but it declined abruptly in 1991, and has averaged about 30% lower since. The number of kittiwake nests in

1989 had fallen back to the late 1970s level, where it has tended to remain (USFWS unpublished data). Productivity of kittiwakes at Chowiet Island was generally high between 1976 and 1981, averaging 0.43 chick per nest, with the highest level (about 1 chick per nest) in 1981. Kittiwakes began failing to produce chicks at least by 1983 (no data were obtained in 1982), however, and in 11 years between then and 1998, the average productivity has been just 0.05 chick per nest (Table 3.4). Accompanying the decline in abundance and collapse of productivity was a delay of 9 days in the mean laying date in the 1990s compared to the 1970s and early 1980s. Poor productivity and delayed laying are both symptomatic of food stress.

Murre abundance on Chowiet Island was stable between 1977 and 1981. Abundance was the same in 1989 when counts were next made, but in contrast to findings for kittiwakes, the population has grown steadily since, standing 30% higher by 1998. As for kittiwakes, the mean laying date of murres was about 10 days later in the 1990s than in the 1970s. Productivity has not varied appreciably between years, except in 1998 when it was very low. The average productivity since 1989 was 0.48 chick per pair, or about the same as at Chisik and Gull islands (Table 3.5).

Trends in fulmar abundance, productivity, and phenology through time exhibited patterns similar to those of kittiwakes and murres. As with murres, abundance has increased: numbers of fulmars grew steadily between 1976 and 1981, and generally continued that trajectory at least through the mid-1990s. An exceptionally low number recorded in 1998, the last year they were counted and the only year since 1995, may be an artifact and not representative of the long-term trend, or it may represent a real decline. As with kittiwakes, productivity of fulmars was lower in the 1980s and 1990s, averaging just 0.24 chick per nest from 1983 through 1998, compared to an average of 0.52 chick per nest from 1976 through 1981. In addition, as found for both kittiwakes and murres, the nesting phenology of fulmars was conspicuously later in the 1990s than in the 1970s.

Little is directly known about diets of kittiwakes and murres at the Semidi Islands, but based on diets of rhinoceros auklets and tufted and horned puffins there (Hatch 1984, Hatch and Sanger 1992), it can be assumed that the usual food sources–sand lance, capelin, and pollock–are most important. These prey also are significant for fulmars. In general, the diets of fulmars overlap extensively with those of kittiwakes and murres, although overall fulmar diets are much more varied (Sanger 1987, Hatch 1993). For example, fulmars are noted for eating large amounts of jellyfish and offal and for feeding jellyfish to chicks.

3.9.3 Conclusions

Seabird populations at colonies in the GOA are very dynamic, with numerous examples of growth and decline during the past 3 decades.

In spite of considerable uncertainty about the magnitude, a widespread decline in the abundance of murres in the GOA may have occurred since the 1970s.

Numbers are clearly down in such diverse habitats as Middleton Island, which lies near the edge of the continental shelf and is the most oceanic of all colonies in the GOA; at Chisik Island, which is arguably the most neritic (nearshore) colony; and apparently at several colonies along the south side of the Alaska Peninsula. Murre numbers are not uniformly down, however; they have increased dramatically at Gull Island during the past 15 years and at the Barren Islands and the Semidi Islands during the past 10 years. Although comparatively little is known about murre productivity, it has been essentially the same in recent years at the declining colony on Chisik Island as at the growing colonies on Gull Island and the Semidi Islands. At Chisik Island, the rate of decline of the population equals the estimated adult mortality–productivity seems to be sufficient to maintain numbers if those birds were recruiting to the population. Therefore, recruitment appears to have been lacking, which could be explained by poor survival of birds raised there or by emigration to other colonies (Piatt personal communication). At Gull Island, productivity and recruitment can account for only about half the rate of population growth, with immigration required to explain the other half.

In most cases, local trends in the abundance of murres and kittiwakes, likely reflect mesoscale or regional processes affecting prey availability. For example, differences in population trends of both species at Chisik Island and Gull Island, and differences in productivity of kittiwakes between the islands, are related to regional variations in the abundance of forage fishes (Piatt unpublished data). The similarity in murre productivity between colonies is likely explained by flexible time budgets, which buffers them against fluctuations in prey (Burger and Piatt 1990, Zador and Piatt 1999).

There is not enough information to determine whether total kittiwake abundance in the GOA has changed one way or another. Many examples of growth, decline, and stasis in individual colonies are available, but there is no apparent broad geographic pattern to the trends. At the few colonies where both kittiwakes and murres have been monitored, abundances of the two species tend to track each other through time. Kittiwakes, along with murres, have declined at Middleton Island and Chisik Island, and apparently increased, with murres, at Gull Island. The one exception is at Chowiet Island in the Semidi Islands, where kittiwakes decreased and murres increased. Elsewhere, kittiwakes have increased at Chiniak Bay on Kodiak Island and remained stable overall in PWS.

There is a strong correlation between population trajectory and long-term average productivity of kittiwakes at many colonies. Those colonies that are increasing in size have the highest productivity; those that are declining have the lowest. Colonies that show no change have intermediate levels. There are various interpretations of such a relationship. One is that productivity and subsequent recruitment of young determines abundance. Another is that kittiwake abundance and productivity simply track changes in prey; that is, in years of high prey abundance, more adults attend colonies and produce greater numbers of chicks than in years of low prey abundance. There would not necessarily have to be any other relationship between the two.

There are conspicuous temporal patterns of kittiwake productivity at many colonies during the past 17 years. Productivity at colonies in PWS and at Gull Island has varied in tandem, with peaks and valleys at about 5-year intervals: high productivity in the mid- to late 1980s, low in the early 1990s, and higher again after 1995. For most of the record, from the early 1980s through the mid-1990s, this pattern was opposite that at Chiniak Bay on Kodiak Island, where productivity peaked in the early 1990s while it bottomed-out in PWS and at Gull Island. Productivity at the three locations tended to track together during the latter half of the 1990s.

Kittiwake productivity and population trends in PWS are well-correlated before 1991 and since 1991, but the sign (positive or negative) of the relationship differs. Before 1991, high productivity was associated with low numbers of birds at the colonies, but since 1991, the relationship has been opposite. A similar switch occurred at about the same time in the relationship between kittiwake productivity in PWS and the abundance of age-1 herring. Such differences in sign and behavior of relationships before and after the 1989-to-1990 regime shift have been pointed out for kittiwakes in the Bering Sea and for various other ecosystem components of the North Pacific. It has been suggested that the differences reflect fundamental changes in ecosystem processes (Springer 1998, Welch et al. 1998, Hare and Mantua 2000).

The peaks and valleys in kittiwake productivity in PWS have punctuated a general declining trend during the longer term. If productivity depends more on prey abundance than on predation, then it seems as though prey have tended to decline throughout PWS in the past 17 years, notwithstanding apparent oscillations.

3.9.4 Future Directions

Seabirds in the GOA are sensitive indicators of variability in the abundance of forage fishes through time and space. How well information from particular species at particular colonies reflects broad patterns of ecosystem behavior in the GOA remains to be seen. The problem is that nearly all of the colonies are situated in habitats with distinct mesoscale or regional properties. PWS is a prime example, where colonies are located at the heads of fjords with and without glaciers, in bays and on islands around the perimeter of the main body of the sound, and on islands in the center of the sound. The Barren Islands and Gull Island are strongly influenced by intense upwelling in Kennedy Entrance that greatly modifies local physical conditions and production processes: waters in the relatively small region are cold, nutrient-rich, and productive. Chisik Island lies in the path of the outflow of warm, nutrient-poor water from Cook Inlet. The Semidi Islands lie at the downstream end of Shelikof Strait and the center of distribution of spawning pollock in the GOA.

Thus, there are various trends in abundance of kittiwakes at the numerous colonies in PWS. Trends in abundance of kittiwakes and murres at the Barren Islands and Gull Island are opposite those at neighboring Chisik Island; and patterns of kittiwake productivity at Gull Island and Chiniak Bay are opposite of each other. Only Middleton Island, which sits isolated near the edge of the continental shelf and the Alaska Stream, and sites on or near the coast of the Alaska Peninsula west of Kodiak Island, which lie in the flow of the Alaska Coastal Current, seem to have the potential to represent gulf-wide variability unencumbered by possibly confusing smaller-scale features.

On the other hand, there is reason for optimism that broad-scale variability is indeed expressed in seabird biology. In spite of a wide variety of local habitat characteristics and population trends of kittiwakes at the many colonies in PWS, and large differences in average long-term productivity among colonies with differing abundance trends, a common temporal pattern of productivity has been shared by almost all colonies. Concordant, clearly defined peaks and valleys have been observed at about 5-year intervals. A sound-wide environmental signal has propagated through the kittiwakes regardless of their location or status.

Moreover, the signal captured by kittiwakes in PWS and expressed in patterns of productivity was also captured by kittiwakes at Gull Island, implying that they may not be as ecologically separated as one might assume considering their geographic distance and characteristics of their environments. And further expanding the spatial dimension, the temporal pattern of sand lance abundance in the vicinity of Middleton Island during the past 15 years, as revealed by its occurrence in diets of rhinoceros auklets and tufted puffins there, matches closely the patterns of kittiwake productivity in PWS and at Gull Island. Although a long geographical stretch, it might not be such a long ecological stretch when viewed broadly, at the GOA scale, rather than in a regional geographic and ecological context. And finally, the kittiwakes at Chiniak Bay also seemed to be attuned to this same signal, notwithstanding the fact that it apparently led to opposite behavior in the local system for some of the time. One thing that is fairly certain of is that the temporal and spatial patterns in various components of seabird biology exhibited in the GOA do reflect underlying patterns in food-web production and ecosystem processes. Because of the range of oceanographic situations surrounding the various colonies, detailed information from them should prove valuable in building a composite view of ecosystem behavior in the GOA.

A variety of approaches to developing a long-term monitoring program in the GOA might work, but the framework that has evolved over the past 3 decades already has proved useful. In-depth work is occurring or has occurred in many years since the 1970s at well-placed locations throughout the GOA. These locations include St. Lazaria Island and Forrester Island in Southeast Alaska; Middleton Island; many colonies in PWS; Chisik Island, Gull Island, and the Barren Islands in Lower Cook Inlet; Kodiak Island; the Semidi Islands; and Aiktak Island on the south side of Unimak Pass. Colonies at these locations share several well-known, tractable species that provide complementary views of the ecosystem, particularly if they are systematically exploited for their contributions. Just as information from each of these colonies will help build a composite broad view of the GOA, information from several species of seabirds at each colony will help build a composite regional view of ecosystem behavior.

Therefore, the most popular species should continue to be the main focus. These are kittiwakes and murres, the species in the GOA with the highest combined score of abundance, distribution, and ease of study. Elements of their biology are sensitive to variability in prey, as seen in the GOA and numerous places elsewhere in the North Pacific and North Atlantic.

Kittiwakes and murres do not do some things as well as second-tier species, namely the puffins. Comparatively little is known about population trends of puffins, despite the fact that they are among the most abundant and widespread of the seabirds in the GOA. This lack of knowledge results because they nest underground. However, puffins have been used to monitor trends in forage fish abundance at numerous colonies throughout the GOA, Aleutian Islands, and British Columbia (Hatch 1984, Vermeer and Westrheim 1984, Hatch and Sanger 1992, Hatch unpublished data, Piatt unpublished data). Diets of the three species of puffins overlap extensively, but each samples the environment somewhat differently: variability in diets among the puffins, locations, and time reveals geographic patterns of forage fish community structure and fluctuations in the abundances of individual species. Puffins return whole, fresh prey to their chicks, a behavior that provides an economical, efficient means of measuring various attributes of forage fish populations, such as individual growth rates within and between years and relative year-class strength.

Third-tier species, the cormorants, guillemots, and storm-petrels, also have attributes that can provide additional useful information. Cormorant and guillemot diets overlap extensively with those of kittiwakes, murres, and puffins, but the cormorants and guillemots sample prey much nearer to colonies and sample additional species not used by the others. Storm-petrels, in contrast, range widely and sample oceanic prey not commonly consumed by any other species. In combination, the diets, abundance, and productivity of the various species of seabirds provide information on prey at multiple spatial scales around colonies. In situations when this information can be easily obtained, it should not be overlooked.

A successful strategy for seabird monitoring will balance breadth (geographic and ecological) with intensity (how much is done at each site). On the one hand, it is important to select a sufficient number of sites to adequately represent a range of environmental conditions in mesoscale and macroscale dimensions. On the other hand, studies must be thorough at each colony. Simply comparing population trends of one or two species may give uncertain, possibly misleading information on underlying conditions of the environment. Without additional information on such things as survival, emigration, recruitment, diet, and physiological condition of the birds, conclusions about causes of population change, or about what population change is saying about the environment versus what productivity is saying, are elusive.

Another need for a long-term monitoring plan is knowledge about when reliable time series begin. For example, several estimates of murre abundance at colonies in the GOA from the 1970s are likely not comparable to more recent systematic counts (Erikson 1995, Roseneau unpublished data). Inappropriate comparisons could result in erroneous conclusions about population changes that might further lead to unsupported speculation concerning broader trends in ecosystem change. This (this what? please clarify)is nicely illustrated by census data from the western Alaska Peninsula. If taken at face value, the information indicates that declines in the abundance of murres have been particularly severe at colonies from the Shumagin Islands westward to Unimak Pass. However, the trend data for two of the colonies, Bird Island and Unga Island, consist of single counts made in each of 2 years at both colonies. The first counts in 1973 were made in mid-June, which is early in the nesting season when murre numbers are unstable at colonies and often much higher than later during the census period (Hatch and Hatch 1989). At another of the colonies, Aiktak Island, the evidence of decline is based on a single count of nearly 13,000 birds in 1980, the first year a census of the colony was performed (Byrd et al. 1999). Single counts in 1982, 1989, and 1990 ranged between 175 and about 8,000 birds. And, the lower boundary of the 90% confidence interval about the mean of multiple counts in 1998 was less than zero, and the upper boundary was nearly as great as the first count in 1980. One must therefore ask if the murre population has indeed changed at all over the long term at Aiktak Island, or at the other colonies in the region where similar uncertainty exists, and if so how much.

In spite of such caveats, information gained from seabirds in the past 3 decades reveals a great deal about the nature of variability in the GOA. We can be certain that the perpetuation and refinement of seabird studies will continue to provide insights and hypotheses useful to the broader goal of understanding the GOA ecosystem.

Crititcal Information Needs

- Continuing information on productivity, population trends, and diets of seabirds in the GOA;
- Information on the annual survival of seabirds at nesting colonies;
- Information on rates of immigration and emigration between colonies;
- Information on functional relationships between seabird abundance, behavior, and productivity and prey availability; and
- Information on functional relationships between elements of food web production at all trophic levels and environmental variability.

3.9.5 General Research Questions

What is the relation between abundance of seabird populations and the availability of forage species, including fish?

- Are alterations in forage fish abundance and community structure brought on by environmental change capable of controlling seabird populations?
- Do local trends in the abundance of murres and kittiwakes reflect mesoscale or regional climatic and oceanographic processes affecting prey availability?
- How can influences of prey availability on seabird abundance be separated from the influences of mesoscale or regional properties unique to the location of the colony, such the presence of glaciers?

What is the relation between commercial fishing and the abundance of seabird populations?

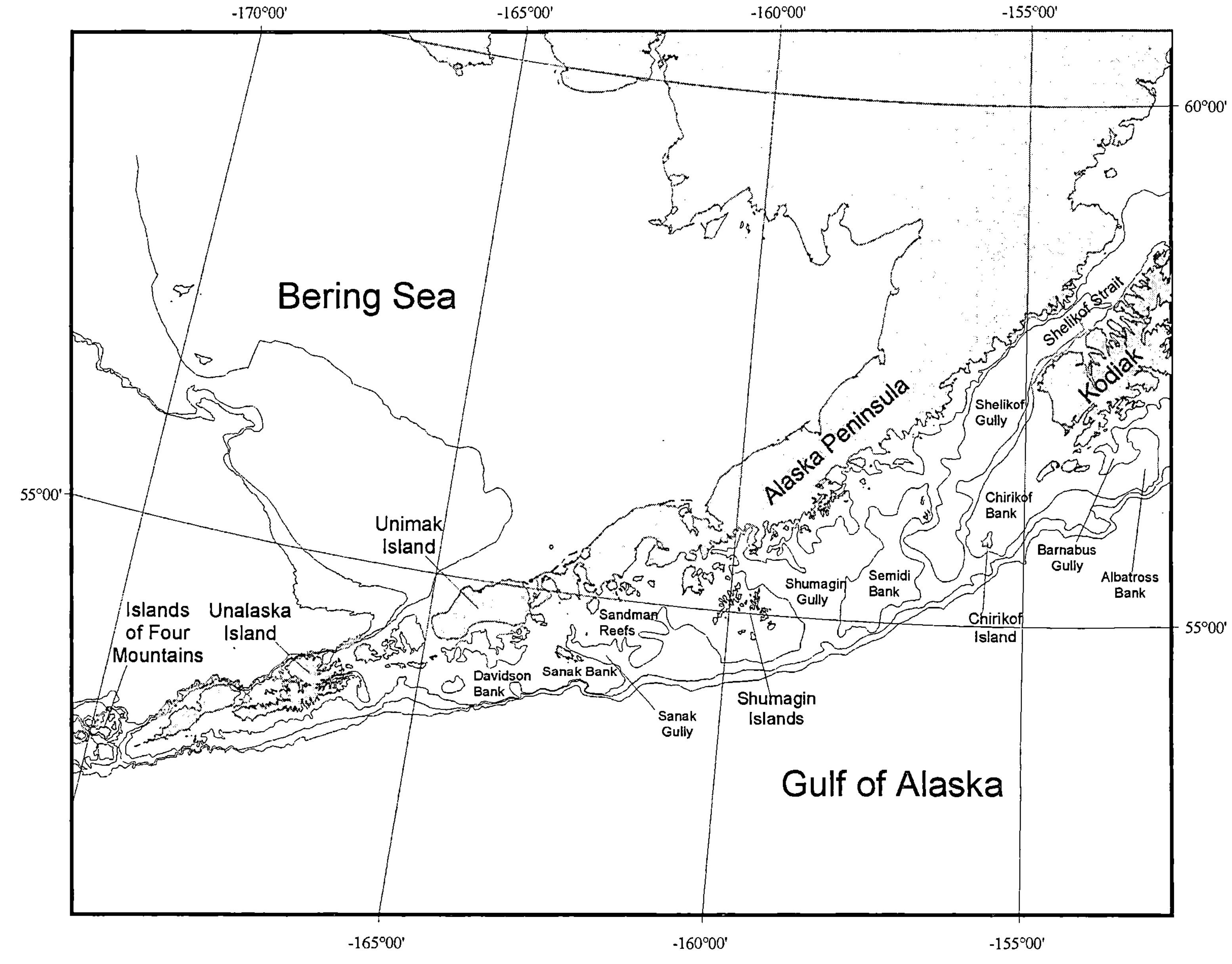
3.10 Fish and Shellfish

3.10.1 Introduction

The GOA is well known for its fish and shellfish because of its long-standing and highly valuable commercial and recreational fisheries (Table 2.1). Less well known are the non-commercial fish and invertebrate species that compose the bulk of the animal biomass in the GOA. As a rule, the economically important species are fairly well known from trawl, trap, and hook catches made by research and commercial vessels (Cooney 1986, Martin 1997a, Witherell 1999a, Kruse et al. 2000a). By the same rule, the majority of fish and shellfish species are less well known, having been sampled during research investigations of limited duration (Feder and Jewett 1986, Rogers et al. 1986, Highsmith et al. 1994a, Purcell et al. 2000, Rooper and Haldorson). Species not commercially harvested are less well studied than commercially harvested species, such as Tanner crab. For example, because no commercial fisheries are allowed for such forage fishes as eulachon, sand lance, capelin, and lantern fish, the fluctuations of their populations are not well documented. More detailed consideration of some of the less economically important, but more ecologically prominent forage species is found in Section 3.8, Forage Species, and some of the less common shellfish species are considered in Section 3.7, Nearshore Benthic Communities.

The marine fish and shellfish of the GOA fall into two major groups (Feder and Jewett 1986, Rogers et al. 1986, Cooney 1986, Cooney 1986, Martin 1997b):

1. Fish–bony fish, sharks, skates, and rays;
2. Shellfish–the mollusks (bivalves including scallops, squid and octopus); and Crustaceans–crabs and shrimp.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Bering Sea
Alaska Peninsula
Shelikof Strait
Kodiak
Shelikof Gully
Chirikof Bank
Barnabus Gully
Albatross Bank
Unimak Island
Shumagin Gully
Semidi Bank
Islands of Four Mountains
Unalaska Island
Sandman Reefs
Chirikof Island
Davidson Bank
Sanak Bank
Sanak Gully
Shumagin Islands
Gulf of Alaska
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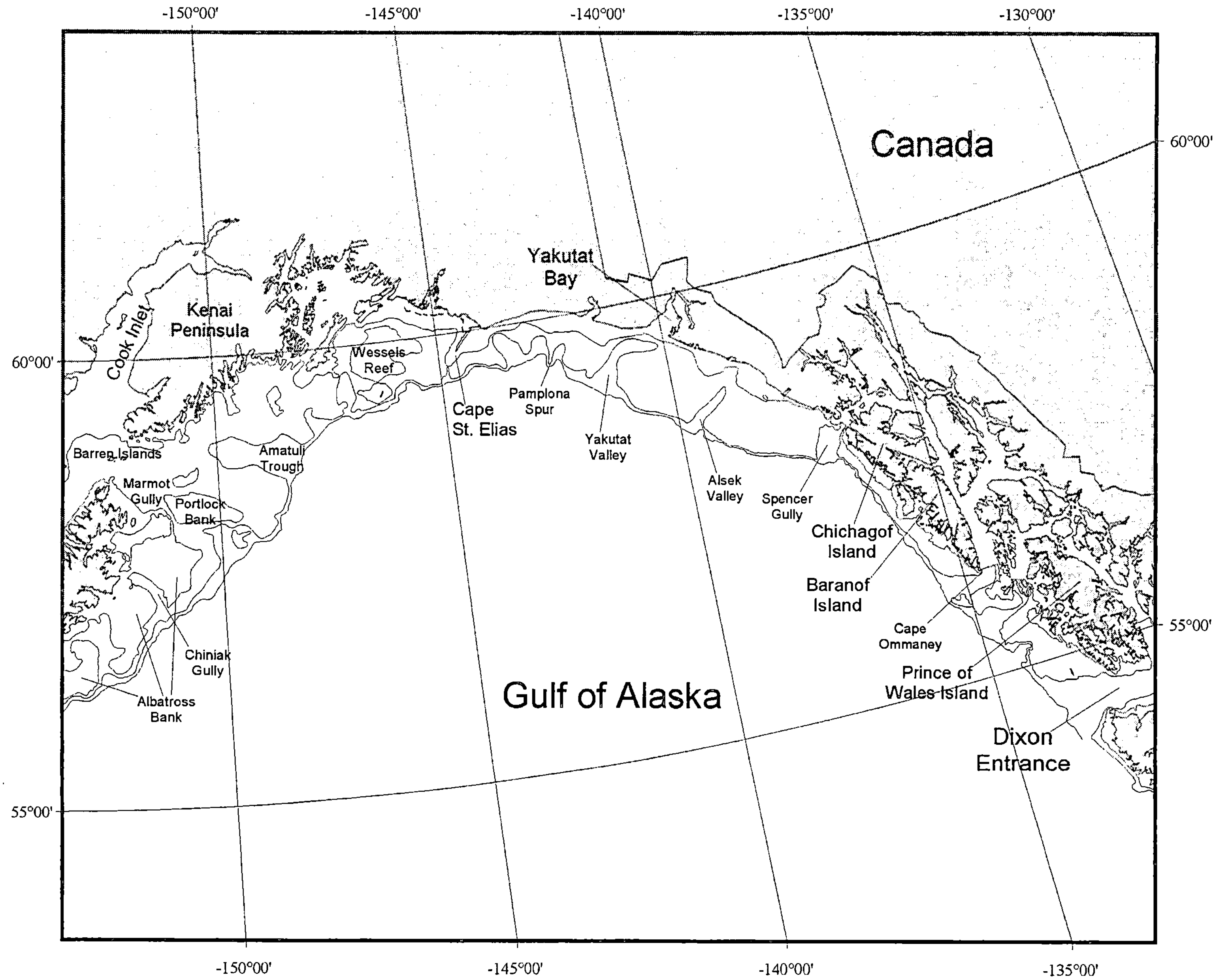
-155°00'

Figure 3.17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Canada
Yakutat Bay
Kenai Peninsula
Cook Inlet
Wessels Reef
Cape St. Elias
Pamplona Spur
Yakutat Valley
Alsek Valley
Spencer Gully
Chichagof Island
Baranof Island
Cape Ommaney
Prince of Wales Island
Dixon Entrance
Barren Islands
Amatuli Trough
Marmot Gully
Portlock Bank
Chiniak Gully
Albatross Bank
Gulf of Alaska

Note that three other ecologically important groups, the pelagic jellyfish (Cnidaria), the bottom dwelling starfish and urchins (Echinodermata), and the segmented worms (Annelida) are not included in the category of the fish and shellfish. A list of all the scientific names and many common names of the species accessible to trawl gear on the continental shelf and shelf break of the GOA is found in Appendix A.

As would be expected with high marine productivity, the fish and shellfish fisheries of the GOA have been among the world's richest in the second half of the 20th century. Major fisheries include, or have included, halibut, groundfish (Pacific cod, pollock, sablefish, Pacific ocean perch and other rockfish, flatfish such as soles and flounders), Pacific herring, multiple species of Pandalid shrimp and red king crab, five species of Pacific salmon, scallops, and other invertebrates (Kruse et al. 2000a, Witherell and Kimball 2000, Cooney 1986). The status of major fisheries and stocks of interest are addressed in the subsections below.

3.10.2 Overview of Fish

Most of the approximately 287 known GOA fish species are bony fish, and the largest number of species is in the sculpin family (Cottidae), followed in order of number of species by the snailfish family (Cyclopteridae), the rockfish family (Scorpaenidae) and the flatfish family (Pleuronectidae) (Tables 3.6 and 3.7) (Cooney 1986). The bony fish dominate the number of species in the GOA, with less than 10% of species being cartilaginous fishes (Petromyzontidae to Acipenseridae, Table 3.6). Species diversity in the fish depends on the type of gear used to sample (Table 3.6). It is important to keep in mid that trawl gear surveys are not designed or intended to estimate species diversity. A comparison of the known fish species composition (Table 3.6, left two columns) to the species composition in the predominant types of trawl gear surveys (Table 3.6, right two columns) shows that trawl gear samples underestimate the fish species diversity of the GOA (Cooney 1986). The longest standing trawl gear surveys for the GOA are limited to the continental shelf and the shelf break (to 500 m before 1999 and to 1,000 m thereafter). The NMFS has measured relative abundance and distribution of the principal groundfish and commercially important invertebrate species (Martin 1997b), and before 1980, the International Pacific Halibut Commission (IPHC) collected information on the abundance, distribution and age structure of halibut (Figure 3.17). Hook and line surveys for Pacific halibut, sablefish, rockfish, and Pacific cod on the continental shelf in the GOA have been conducted by the IPHC since 1962 (Clark et al.).

FIGURE 3.17

FIGURE NOT YET PREPARED (after Martin D.H. Pages 4 and 5)

Table 3.6 Fish Families and the Approximate Number of Genera and Species Reported from the Gulf of Alaska

Family	Quast and Hall[1]		Miscellaneous Surveys[2]	
	Number of Genera	Number of Species	Number of Genera	Number of Species
Petromyzontidae	2	3	-	-
Hexanchidae	1	1	-	-
Lamnidae	2	2	1	1
Carcharhinidae	1	1	-	-
Squalidae	2	2	1	1
Rajidae	1	7	1	4
Acipenseridae	1	2	-	-
Clupeidae	2	2	1	1
Salmonidae	6	12	1	3
Osmeridae	5	6	5	6
Bathylagidae	1	4	-	-
Opisthoproctidae	1	1	-	-
Gonostomatidae	2	4	-	-
Melanostomiidae	1	1	-	-
Chauliodontidae	1	1	1	1
Alepocephalidae	1	1	-	-
Anotopteridae	1	1	-	-
Scopelarchidae	1	1	-	-
Myctophidae	7	10	1	1
Oneirodidae	1	3	-	-
Moridae	1	1	-	-
Gadidae	5	5	5	5
Ophidiidae	2	2	-	-
Zoarcidae	6	11	4	7
Macrouridae	1	3	1	1
Scomberesocidae	1	1	1	1
Melamphaidae	3	3	-	-
Zeidae	1	1	-	-
Lampridae	1	1	-	-
Trachipteridae	1	1	-	-
Gasterosteidae	2	2	-	-
Scorpaenidae	2	22	2	30
Hexagrammidae	3	6	3	5
Anoplopomatidae	2	2	1	1
Cottidae	30	54	15	24
Psychrolutidae	1	1	-	-

Table 3.6 Fish Families and the Approximate Number of Genera and Species Reported from the Gulf of Alaska

Family	Quast and Hall[1] Number of Genera	Quast and Hall[1] Number of Species	Miscellaneous Surveys[2] Number of Genera	Miscellaneous Surveys[2] Number of Species
Agonidae	8	12	8	9
Cyclopteridae	12	38	5	7
Bramidae	1	1	-	-
Pentacerotidae	1	1	-	-
Sphyracnidae	1	1	-	-
Trichodontidae	2	2	1	1
Bathymasteridae	2	4	2	2
Anarhichadidae	1	1	1	1
Stichaeidae	10	15	4	6
Ptilichthyidae	1	1	-	-
Pholididae	2	4	-	-
Scytalinidae	1	1	-	-
Zaproridae	1	1	1	1
Ammodytidae	1	1	1	1
Scombridae	2	2	-	-
Centrolophidae	1	1	-	-
Bothidae	1	1	-	-
Pleuronectidae	15	17	15	16
Cryptacanthodidae[3]	2	2	2	2
Totals	**167**	287	84	138

Sources: Hood and Zimmerman 1986 (after Ronholt, Shippen, and Brown 1978).

[1]After Quast and Hall (1972).

[2]Gulf of Alaska exploratory, BCF, IPHC, and NNIFS trawl survey data.

[3]Quast and Hall (1972) include these genera and species in the family Stichaeidae while Hart (1973) recognizes a separate family.

Table 3.7 Proportion of the Total Species Composition of Gulf of Alaska Fish Fauna Contributed by the 10 Dominant Fish Families in Two Different Surveys

Family[1]	Percentage of Total Fish Species	Family[2]	Percentage of Total Fish Species
Cottidae	19	Scorpaenidae	10
Cyclopteridae	13	Cottidae	8
Scorpaenidae	8	Pleuronectidae	6
Pleuronectidae	6	Agonidae	3
Stichaeidae	5	Zoarcidae	2
Salmonidae	4	Cyclopteridae	2
Agonidae	4	Stichaeidae	2
Zoaricidae	4	Osmeridae	2
Myctophidae	3	Gadidae	2
Rajidae	2	Hexagrammidae	2
Total	**68**		**39**

Source: Hood and Zimmerman 1986

[1]From Quast and Hall (1972).

[2]From GOA exploratory cruises and resource assessment surveys.

On the basis of the biomass available to trawl gear on the continental shelf and shelf break, flatfish and rockfish dominate the fish fauna in most areas of the GOA. As of 1996, a flatfish species, arrowtooth flounder, dominated the overall trawl survey of the fish biomass in the GOA, followed by Pacific ocean perch (rockfish), walleye pollock (gadid), Pacific halibut (flatfish), and Pacific cod (gadid) (Martin 1997a). Biomass of the arrowtooth flounder is approaching 2 million mt, and its biomass has been steadily increasing since 1977 (Witherell 1999a). Of the next 15 largest biomasses of species in the 1996 NMFS survey, 6 were flatfish and 5 were rockfish.

Geographic distributions of GOA fish biomass in the NMFS trawl surveys are different from the overall total. In the western GOA, Atka mackeral (Hexagrammid) had the highest biomass in the Shumagin Islands, but this species was not among the 20 largest biomasses of species in the four other INPFC areas of the GOA. Arrowtooth flounder dominate the trawl survey biomass throughout the GOA. They are the most or second most abundant in all five areas. Flatfish and especially soles comprise a large number of high-biomass species in the western and northwestern GOA (Shumagin Islands, Chirikof, and Kodiak), and rockfish have a large number of high-biomass species in the northeastern and eastern GOA (Yakutat and Southeast). Pollock and cod are a dominant part of the biomass in the western GOA, but less so in the east. Pacific sleeper sharks are among the 20 largest biomasses of species in the north (Chirikof, Kodiak, and Yakutat), but not in the south (Shumagin Islands and Southeast). The only anadromous species, the eulachon, occurs among the 20 largest biomasses in the north, but not in the south.

With the use of a variety of gear types, including trawl net, try net, trammel net, beach seine, and tow net in waters less than 100 m, Rogers et al. (1986) provided a detailed image of the distribution of fish species and biomass with depth and by region. As was the case for the 1996 NMFS trawl surveys, species composition and relative biomass of fish species in multi-gear surveys change substantially in moving from the nearshore toward offshore areas in the GOA, as well as from one region to the next. The findings of the multiple gear surveys were consistent with the trawl survey observations in that shallow (smaller than 100 m) fish assemblages were more diverse in the north and west of the GOA than in the northeast and east (Table 3.8 in comparison to Table 3.6).

Table 3.8. Comparison of the Number of Fish Families and Species Found at less than 100 m in Different Regions of the GOA

Location	Number of Families	Number of Species
Kodiak	22	101
Lower Cook Inlet	25	105
Prince William Sound	18	72
Southeast Alaska	NA	51

Information summarized from Rogers et al. (1986).

NA = not available

Other trends in distribution correspond to reproduction and seasonal changes in shallow waters in some species of nearshore fishes. Estuarine bays in the Kodiak archipelago are nursery areas, with larvae and juveniles being found in nearshore and pelagic habitats within bays (Rogers et al. 1986). Blackburn (1979 in [Rogers et al. 1986]) found a trend of larger fish with increasing depth in studies of Ugak Bay and Alitak Bay on Kodiak Island. Most species of nearshore fish apparently move to deeper water in the winter. In Lower Cook Inlet and Southeast Alaska, juveniles and other smaller size classes of the species of local fish assemblages are found close to shore, water temperatures permitting, and larger size classes are found farther offshore at depths greater than 30 m at all times of the year.

Nearshore areas of the GOA provide rearing environments for the juveniles of many fish species. Important nursery grounds for juvenile flatfishes, such as soles and Pacific halibut, are found in waters of Kachemak Bay and other waters of Lower Cook Inlet, as well as in Chiniak Bay on Kodiak Island (Norcross 1998). In Kachemak Bay, summer habitats of some juvenile flatfishes are shallower than winter habitats. Juvenile flatfish distributions in coastal waters are defined by substrate type, typically mud and mud-sand, and by depth, typically 10 to 80 m, and in the case of Chiniak Bay, by temperature. Deep-water and shallow-water assemblages were identified for the groundfish communities in both Kachemak and Chiniak bays; however, the limiting depths were different for the se two localities (Norcross 1998, Mueter and Norcross 1999).

Both salmon and groundfish populations in the northeastern Pacific appear to vary annually in concert with features of climate, but the responses appear to be different (Francis et al. 1998). Annual groundfish recruitments follow a cycle with a roughly 10-year period that may be related to the ENSO (Hollowed and Wooster 1992), whereas salmon abundance changes sharply at intervals of 20 to 25 years in concert with the PDO (Brodeur et al. 1996). The ENSO and the PDO were shown to be independent of one another (Mantua et al. 1997). The opposite responses of groundfish and salmon (positive) and crab (negative) recruitment to intensified Aleutian lows may be because different species-specific mechanisms are invoked by the same weather pattern. Because the groundfish species described by Hollowed and Wooster (1992, 1995) were mostly winter spawners, Zheng and Kruse (2000b) hypothesize that strengthened Aleutian lows increase advection of eggs and larvae of groundfish toward onshore nursery areas, improving survival. Salmon, on the other hand, benefit from increased production of prey items under intense lows. The possible links between Aleutian lows, PDOs, and ENSO and populations of fish and other animals are discussed further below and in a recent review paper (Francis et al. 1998).

3.10.2.1 Salmon

The GOA is the crossroads of the world for Pacific salmon. Salmon from Japan, Russia, all of Alaska, British Columbia, and the Pacific Northwest spend part of each life cycle in the GOA (Myers et al. 2000). Five species of salmon–pink, chum, sockeye, coho and Chinook–are very common in the GOA. These species appear in the GOA as early as the first year of life (all pink, chum, and ocean type chinook and some sockeye); however, others may appear during the second (all coho and stream-type Chinook and most sockeye) and rarely during the third or later years (some sockeye) (see (Groot and Margolis 1991). Ecologically, the salmon species may be divided into two broad groups, marine planktivores (pink, chum, and sockeye) and marine piscivores (coho and chinook). Further ecological differentiation is apparent within planktivores. For example, the size groups of plankton consumed by chum and sockeye are inferred to be quite different, because chum use short stubby gill rakers to separate food from water, and sockeye have long feathery gill rakers as filters.

Distribution within the GOA changes with time after marine entry (Nagasawa 2000), as salmon disperse among coastal feeding grounds according to species and stock, age, size, feeding behavior, food preferences, and other factors (Myers et al. 2000). During the first year of marine life, salmon are located in estuaries, bays, and coastal areas within the ACC and continental shelf (Myers et al. 2000). With time and growth, first-year salmon move farther away from their river of origin and father offshore. First-year salmon move out of the ACC into colder waters in fall and winter of their first year at sea.

Salmon of all ages are thought to exhibit seasonal migrations in spring and fall between onshore and offshore marine areas. In the fall, salmon of all ages move offshore to spend the winter in waters between 4° C and 8° C that are relatively poor in food, perhaps as an energy conservation strategy for surviving the winter (Nagasawa 2000). In the spring, salmon move onshore into waters that may reach 15° C where food sources are relatively abundant.

Salmon populations overall are at very high levels in Alaska, with the notable exceptions of western Alaska chum and chinook populations originating in drainages between Norton Sound in the north and the Kuskokwim River, west of Bristol Bay (ADF&G 1998). On Norton Sound, the chum salmon populations of the Penny and Cripple rivers have exhibited very low to zero spawning stocks in the past 5 years. Another notable exception to the record high levels of Alaska salmon production are the Kvichak River sockeye populations of Bristol Bay, which have faltered. Some "off-peak cycle" brood years have recently failed to produce as expected (Kruse et al. 2000b).

The situation in Western Alaska notwithstanding, the 1999 commercial harvest of 404,000 mt of salmon in Alaska was the second largest in recorded history behind 1995 (451,000 mt) (Kruse et al. 2000b). A large portion of the record harvests in 1999 was pink salmon from areas adjacent to the GOA, PWS, and Southeast Alaska. The status of salmon populations and fisheries in the following areas were recently evaluated in terms of levels of harvest and spawning escapements: areas coincident with habitats in the north central GOA of the Stellar sea lion, which is listed as an endangered species under the Endangered Species Act of 1973 (ESA); Kodiak; the Alaska Peninsula; and Bristol Bay All major commercial salmon stocks were judged to be healthy, with the exception of the Kvichak River off-cycle brood years (Kruse et al. 2000b).

Given that marine migration patterns of each stock are thought to be characteristic and somewhat unique (Myers et al. 2000), the contrast in the status of salmon stocks between Western and Southcentral and Southeast Alaska offers some intriguing research questions about the role of marine processes in salmon production (Cooney 1984). Understanding the processes that connect salmon production to climate, marine food production, and fishing requires understanding of the marine pathways of the salmon through time (Beamish et al. 1999b). Therefore, research approaches to understanding changes in salmon abundance on annual and decadal scales need to encompass localities that are representative of the full life cycle of the salmon and, in particular, in estuarine and marine environments. Scientific information on freshwater localities is far more common than that available for estuarine and marine areas. Given the current state of information on both hatchery and wild salmon, it is highly desirable to focus current and future efforts on estuaries and marine areas for understanding migratory pathways and other habitats, physiological indicators of individual health, trophic dynamics, and the forcing effects of weather and oceanographic processes (Brodeur et al. 2000).

3.10.2.2 Pacific Herring

Pacific herring (herring) populations (Funk 2000) occur in the northeast GOA, with commercial concentrations in Southeast Alaska (Sitka), PWS, western Lower Cook Inlet, and occasionally around Kodiak. Most of the historical information on herring in the GOA comes from coastal marine fisheries that started in Alaska in 1878 (Kruse et al. 2000b); however, intensive ecological investigations at the end of the 20th century have added information on early life history (Norcross et al. 1999). Herring deposit eggs onto vegetation in the intertidal and near subtidal waters in late spring, undergo a period of larval drift, and spend the first summer and winter nearshore in sheltered embayments. Transport of larvae by currents in relation to sites that are suitable summer feeding and overwintering grounds is likely an important factor affecting survival in the first year of life in PWS (Norcross et al. 1999), as is the nutritional status of these age-0 herring in the fall of the year (Foy and Paul 1999). Some portion of the mature herring must migrate annually between onshore spawning grounds and offshore feeding grounds; however, the geography of the life cycle between spawning and maturation is less certain.

Although the geographic scope of the herring life cycle in the Bering Sea is fairly well understood, inferences from the Bering Sea to the GOA are not direct because of apparent differences in life history strategies between the herring of the two regions (Funk 2000). Adult herring in the GOA are smaller and have shorter life spans than those in the Bering Sea. Perhaps GOA herring migrate shorter distances to food sources that are not as rich as those available to Bering Sea herring, which migrate long distances from spawning to feed among the rich food sources of the continental shelf break (Funk 2000). Genetic analyses indicate that Bering Sea and GOA herring populations are reproductively isolated (Funk 2000).

Another ecologically significant characteristic of Pacific herring is the temporal change in size at age over time (Brown 2000). Annual deviations from long-term (1927 to 1998) mean length at age for Sitka Sound herring indicate a decadal-scale oscillation between positive and negative deviations. This finding is consistent with the reported coincidence of size-at-age data for Pacific herring with the PDO (Ware 1991). Herring may be affected by ENSO events. Decreased catches, recruitments, and weight-at-age of herring are at times associated with ENSO events. Seabirds in the GOA that depend on herring and other pelagic forage species showed widespread mortalities and breeding failures during the ENSO events of 1983 and 1993 (Bailey et al. 1995b). The similarities between the annual patterns of abundance and the location of weather systems (annual geographically averaged sea-level atmospheric pressure) are not as clear with herring as for other fish species, such as salmon. The difference may result because herring populations tend to be dominated by the occasional strong year class and show considerable variability in landings through the years.

The current status of herring populations may be closely related to historical fishing patterns. Long-term changes associated with commercial fishing have occurred in the apparent geographic distribution and abundance of GOA herring. Herring-reduction fisheries (oil and meal) from 1878 to 1967 reached a peak harvest of 142,000 mt in 1934. That exploitation rates were high may be inferred from the fact that some locations of major herring-reduction fisheries, such as Seldovia Bay (Kenai Peninsula and Lower Cook Inlet) are now devoid of herring. It is speculated that reduction fisheries at geographic bottlenecks between herring spawning and feeding grounds, such as the entrance to Seldovia Bay and the passes of southwestern PWS, were able to apply very high exploitation rates to the adult population. Harvest management applied by the State of Alaska relies on biomass estimates, and harvests are held to a small fraction of the estimated biomass. Harvest is not allowed until the population estimate rises above a minimum or "threshold" biomass level.

Recent statewide herring harvests have averaged less than a third of the 1934 peak. Direct comparison of past and present catch statistics is problematic, however, because current rates of harvest are thought to be substantially below those applied in 1934 (Kruse et al. 2000b). Also note that recent statewide figures for herring harvests include substantial harvests from outside the GOA, and herring-reduction fisheries were located in the GOA. Populations of herring were targeted for sac roe starting in the 1970s and for sac roe and roe on kelp in the 1980s. Regional herring population status is variable. Population levels of herring in PWS remained at low levels in 2000, and commercial harvests were not allowed in 1994, 1995, and 1996, nor since 1998. In 1999, fishing operations were halted because of low biomass and poor recruitment. Disease is strongly suspected as a factor in keeping the population levels low. The herring fishery of Lower Cook

Inlet in Kamishak Bay closed in 1999 after a very small catch in 1998 and remains closed because of low biomass levels. Catches in the Kodiak fishery for herring sac roe are declining. The bait fishery in Shelikof Strait was closed in 1999 because of its possible relation to depressed Kamishak Bay herring populations.

Significant questions remain about the geographic extent of the stocks to which the biomass estimates and fishing exploitation rates may apply in PWS (Norcross et al. 1999). The geomorphology of PWS in relation to currents plays an important role in determining the retention of larvae in nearshore areas conducive to growth and survival. The degree to which spawning aggregations of herring may represent individual stocks is a significant question, because the actual exploitation rate of herring in PWS depends on how many stocks are defined. Although it is not clear how many stocks of herring occupy PWS, conditions appear to favor more than one spawning stock (Norcross et al. 1999).

Water temperatures appear to play important roles in growth and survival of age-0 herring. Warm summer water temperatures may be conducive to growth and survival; however, the opposite appears to be true of warm water temperatures in spring and winter. Increased metabolic demands imposed by warm water on yolk-sac larvae and overwintering age-0 herring could decrease survival (Norcross et al. 1999). Availability of food before winter, and perhaps during winter may be key to survival of age-0 herring. Input of food from the GOA may be an important key to survival for age-0 herring at some localities. Differential survival among nursery areas because of interannual variation in climate and accessibility of GOA food sources could be a key determinant of year-class strength in PWS. The sources of variability mean that geographic locality is no guarantee of any particular level of survival from year to year. Sampling whole body energy content of age-0 herring at the end of the first winter among bays could provide an indicator of year class strength (Norcross et al. 1999).

Questions relating to the ability of disease outbreaks to control herring populations have recently been explored. Work has identified the diseases, Viral Hemorrhagic Septicemia and a fungus as factors potentially limiting the abundance of herring in PWS (Hostettler et al. 2000, Crane and Galasso 1999).

3.10.2.3 Pollock

Pollock are an ecologically dominant and economically important cod-like fish in the GOA. They appear to spawn at the same locations within the same marine areas each year, with location of spawning and migrations of adults linked to patterns of larval drift and locations of feeding grounds (Bailey et al. 1999). Spawning occurs at depths of 100 to 400 m, and as a result, the distributions of eggs and larvae in some areas may have been well below the depths of historical ichthyoplankton surveys. Pollock larvae feed on early developmental stages of copepods and, as juveniles, move on to feed on larger zooplankton such as euphausiids and small fishes, including pollock. Although cannibalism is regarded as significant in the Bering Sea, it is not thought to be a significant factor in the

GOA. Pollock eggs and larvae are important sources of food for other zooplankters, and year class strength in pollock is thought to be related abundances of marine mammals and seabirds, at least in the Bering Sea.

Pollock mature at about age 4 and may live as long as 20 years (Bailey et al. 1999). Adult walleye pollock are distributed throughout the GOA at depths above 500 m. A substantial portion (45%) of the total pollock biomass as well as the highest catches per unit effort (CPUEs) of the 1996 NMFS survey were found at less than 200 m in the area between Kodiak and Chirikof islands (Martin 1997a). In the western GOA, the highest pollock catches and CPUEs of the 1996 NMFS trawl survey were found at less than 200 m, whereas in Yakutat and Southeast Alaska the substantial availability of pollock to trawl gear persists above 300 m. Pollock larger than 30 cm were rarely found above 200 m in the eastern GOA in 1996 (Yakutat and Southeast), although pollock of all sizes (about 10 to 70 cm) were found at all depths down to 500 m in the western GOA (Martin 1997a). Although pollock are commonly found in the outer continental shelf and slope, they may also be found in nearshore areas where they may be important predators and prey; for example, in PWS (Willette et al. in press).

Populations of pollock in the GOA are considered to be separate from those in the Bering Sea (Bailey et al. 1999). Among the most commercially important of the GOA groundfish species, exploitable biomasses of pollock populations in 1999 were estimated at 738,000 mt, down from a peak of about 3 million mt in 1982 (Witherell 1999b). Annual numbers of 2-year-old pollock entering the fishable population (recruitment) from 198 to 1987 were erratic and usually lower than recruitments estimated in 1977 to 1980.

Following the climatic regime shift in 1978, pollock and other cod-like fish have dramatically increased, replacing shrimp in nearshore waters as the dominant group of organisms caught in mid-water trawls on the shelf (Piatt and Anderson 1996). Recruitment in pollock is heavily influenced by oceanographic conditions experienced by the eggs and larvae. Good conditions for juveniles of the 1976 and 1978 year class contributed to the 1982 peak in pollock biomass in the GOA (Bailey et al. 1999). Populations have gradually declined since then (Witherell 1999b). Increasing mortality schedules in 1986 to 1991 may indicate increasing predation and deteriorating physical conditions for both juveniles and adults in the GOA (Bailey et al. 1999). The larger-than-average year class for GOA Pollock in 1988 may be related to high rates of juvenile growth coincident with warm water temperatures, lack of winds, low predator abundance, and low larval mortality rates (Bailey et al. 1996). As has been shown to be the case with other groundfish species, GOA pollock recruitments are positively correlated with ENSO events (Bailey et al. 1995b).

Issues in the management of pollock that currently remain unresolved include the geographic boundaries of stocks, their extent of migration, the effects of fishing in one geographic locale on the populations of pollock and predators in other geographic locales, and what controls the annual recruitment of young pollock to the fishable populations (Bailey et al. 1999). In relation to stock structure, spawning aggregations in PWS, the Shumagin Islands (southwest Kodiak), and Shelikof Strait (separating Kodiak from the Alaska Peninsula) may represent separate stocks. Conditions of weather and changing ocean currents and eddies in the Shelikof Strait have the capacity to alter survival of pollock larvae from year to year (Bailey et al. 1995a). In particular, the effects of shifts in the strength of the ACC on larval transport pose important questions for how year class strength is determined. In 1996, anomalous relaxation of winds resulted in a dramatic increase in larval retention in the Shelikof basin. Increased larval retention may be favorable to survival of pollock larvae in this area, with some exceptions (Bailey et al. 1999).

3.10.2.4 Pacific Cod

Pacific cod is a groundfish with demersal eggs and larvae found throughout the GOA on the continental shelf and shelf break. Pacific cod of the GOA are also an economically and ecologically important species. Pacific cod had an estimated fishable population of 648,000 mt in 1999, which is on the low end of the range of 600,000 to 950,000 mt estimated for 1978 to 1999. Annual recruitments of GOA Pacific cod have been relatively stable since 1978, with exceptionally large numbers of 3-year-old recruits appearing in 1980 and 1998. Biomass of the dominant flatfish in the GOA, the arrowtooth flounder, is approaching 2 million mt. Arrowtooth flounder is not heavily harvested, and their biomass has been steadily increasing since 1977.

Pacific cod are found throughout the GOA at depths less than 500 m. They are most abundant in the western GOA (Kodiak, Chirikof and Shumagin Islands) where Pacific cod larger than 30 cm are found at all depths above 300 m, but smaller individuals are rarely found at depths less than 100 m (Martin 1997a).

3.10.2.5 Halibut

Pacific halibut are common throughout the GOA at depths less than 400 m, and halibut are available to trawl gear at depths of 500 m (Martin 1997a). In the 1996 NMFS trawl survey, the largest catches and the highest CPUE were found at depths of less than 100 m east southeast of Kodiak on the Albatross Banks (Figure 3.17). In most areas of the GOA, the average weight and length of halibut caught in trawl gear increases with depth, even though the CPUE declines with depth, particularly in the western GOA (Shumagin Islands, Chirikof, and Kodiak) (Martin 1997a).

The exploitable biomass of another flatfish, the highly prized Pacific halibut, in 1999 was estimated at 258,000 mt, which is above average for 1974 to 1999 (Witherell 1999b). Exploitable biomass of Pacific halibut was also increasing from 1974 to 1988, after which it declined slightly.

Pacific halibut appear to undergo decadal-scale changes in recruitment, which have been correlated with both the 18.6-year cycle for lunar nodal tide (Parker et al. 1995) and the PDO.

3.10.3 Overview of Shellfish and Benthic Invertebrates

Shellfish are commonly found on or near the surface of the sea floor; they are epibenthic, as adults, and in the water column, pelagic, for varying lengths of time as pre-adults. Exceptions to this rule abound, particularly among mollusks such as squid, which live free of the bottom as adults. Beyond the nearshore environment (at depths greater than 25 m), the shellfish and other invertebrates dominate the number of species and the biomass of the bottom, just as other assemblages of invertebrates dominate the nearshore (see Section 3.7). Among the shellfish, the arthropods and mollusks often have the largest number of species. For example, of 287 species of bottom fauna identified in waters deeper than 25 m in Lower Cook Inlet, more than 67% were arthropods and mollusks (Feder and Jewett 1986). Many of the commercially important species of the GOA are dependent for food to a greater or lesser extent on benthic invertebrates discussed here. (Commercially important crabs and shrimp are discussed below.) Commercial crabs and shrimps, and scallops, join the fish species of Pacific cod, walleye pollock, halibut, and Pacific Ocean perch as members of the subtidal benthic food web for part of each life cycle. Detritus, bacteria, and microalgae form the base for the benthic invertebrates of the GOA continental shelf, which are predominantly filter feeders (60%), and detritus eaters (33%) (Semenov 1965 in [Feder and Jewett 1986]). Small mollusks, small crustaceans, polychaete annelids, and other worm-like invertebrates make up the filter-feeding and detrivore component of this food web.

Regional differences are pronounced in the benthic food webs of the GOA. The eastern GOA has few filter feeders and lower average biomass relative to the northern and western GOA, in large part because of the nature of substrates and currents. In particular the benthic species composition and productivity in the GOA is determined in part by the ACC, particularly in the embayments and fjords (Feder and Jewett 1986). The ACC brings freshwater to the environments containing the pelagic shellfish larvae and heavy sediment loads that define the bottom habitats of the later stages of the life cycle. Biomass of filter feeders on the continental shelf in the western Gulf (138 grams per square meter [g/m^2]) is far higher than that found in the northeastern or eastern GOA combined (33.2 g/m^2). Biomasses of detritus feeders in the western (31 g/m^2) and eastern (12 g/m^2) GOA are lower than those found in the northeastern GOA (43 g/m^2). Biomasses of all trophic groups on the shelf break are lower than those of the adjacent shelf. The distribution of benthic invertebrates in the GOA attests to the validity of the hypothesis that the type of bottom sediment, as influenced by proximity to alluvial inputs and currents, determines the species composition, production, and productivities of benthic communities (Semenov 1965 in (Feder and Jewett 1986). Sediment size is dominant among the factors controlling the distribution of benthic species (Feder and Jewett 1986).

3.10.3.1 Crab

The principal commercial crab species in the GOA are the king crabs (*Paralithodes* spp.), the tanner crab (*Chionoecetes bairdi*), and the Dungeness crab

(*Cancer magister*). All species have benthic adults and pelagic larvae, although the life history strategies vary substantially within and among species. For example, the pelagic stages of the red king crab are herbivorous; those of the tanner crab are carnivorous; and those of the golden king crab do not feed until they metamorphose into the benthic stages. The benthic stages of all crab species feed to a large extent on the less well known invertebrates of the benthic environments (Feder and Paul 1980a, Jewett and Feder 1983, Feder and Jewett 1986) discussed briefly above under the shellfish overview .

The status of crab populations is relatively poor in comparison to the groundfish populations (Kruse et al. 2000a). Crab catches in the GOA have shown sharp changes with time, perhaps indicative of sensitivity to climatic forcing in some species, to fishing, or a to combination of factors (Zheng and Kruse 2000b). The red king crab stock of the GOA collapsed in the early 1980s and currently shows no signs of recovery. The tanner crab populations in PWS, Cook Inlet, Kodiak, and the Alaska Peninsula have declined to low levels in the early 1990s, and harvest levels have been sharply reduced (Kruse et al. 2000b)

In a study of time-series data on recruitment for 15 crab stocks in the Bering Sea, Aleutian Islands, and GOA, time trends in 7 of 15 crab stocks are significantly correlated with time series of the strength of Aleutian Low climate regimes (Zheng and Kruse 2000a). Time trends in recruitments among some king crab stocks were correlated over broad geographic regions, suggesting a significant role of environmental forcing in regulation of population numbers for these species. The increased ocean productivity associated with the intense Aleutian Low and warmer temperatures was inversely related to recruitment for 7 of the 15 crab stocks. The seven significantly negative correlations between ocean productivity and crab recruitment were from Bristol Bay, Cook Inlet ,and the GOA. Crab stocks declined as the Aleutian Low intensified. A significant inverse relation between the brood strength of red king crab and Aleutian Low intensity was reported earlier for one of the stocks in this study, red king crab from Bristol Bay (Tyler and Kruse 1996).

Tyler and Kruse (1996, 1997) and (Zheng and Kruse 2000a) have articulated an explicit series of hypotheses linking features of physical and geological oceanography to the reproductive and developmental biology of red king and tanner crab. The hypotheses explain observed relations between climate and recruitment. Tanner and red king crab in the Bering Sea are thought to respond differently to the physical factors associated with the Aleutian Low because of the distribution of the different types of sea bottom required by the post-planktonic stage of each species. Suitable bottom habitat for red king crabs in the Bering Sea is more generally nearshore, whereas suitable bottom habitat for tanner crab is offshore. Intense Aleutian Low conditions favor surface currents that carry or hold planktonic crab larvae onshore, whereas weak Aleutian Low conditions favor surface currents that move larvae offshore. The process may not be species specific, but stock specific, depending on the location of suitable settling habitat in relation to the prevailing currents. In the case of red king crab, Zheng and Kruse (2000b) explain the apparent paradox of lowered recruitment for red king crab during periods of increased primary productivity. Red king crab eat diatoms, but show a preference for diatoms similar to *Thalassiosira* spp., which dominate in years of weak lows and stable water columns. Strong lows contribute to well-mixed water columns and a diverse assemblage of primary producers, which may be unfavorable for red king crab larvae, but favorable for tanner crab larvae. Tanner crab larvae eat copepods, which are favored by the higher temperatures associated with intense lows.

Recently completed modeling studies (Rosenkrantz 1999) support climatic variables as determinants of recruitment success in tanner crab. Predominant wind direction and temperature of bottom water were strongly related to strength of tanner crab year classes in the Bering Sea. Northeast winds are thought to set up ocean transport processes that promote year-class strength by carrying the larvae toward suitable habitat. Elevated bottom-water temperatures were expected to augment the effect of northeast wind by increasing survival of newly hatched larvae (Rosenkrantz 1999).

3.10.3.2 Shrimp

The shrimp were once among the dominant benthic epifauna in Lower Cook Inlet and Kodiak and along the Alaska Peninsula (Anderson and Piatt 1999, Feder and Jewett 1986) and of substantial commercial importance in the GOA. Five species of Pandalid shrimp dominated the commercial catches, which occurred west of 144° W longitude in PWS, Cook Inlet, Kodiak and along the Alaska Peninsula (Kruse et al. 2000b). Shrimp fisheries in the GOA peaked at 67,000 mt in 1973, reached 59,000 mt in 1977, and declined thereafter to the point where shrimp fishing is virtually nonexistent in the GOA today.

Regional fisheries follow the pattern seen for the GOA as a whole. The trawl fishery for northern shrimp *(Pandalus borealis)* in Lower Cook Inlet peaked at 2,800 mt in 1980 to 1981 and was closed in 1987 to 1988. The fishery for northern and sidestriped shrimp (*P. dispar*) along the outer Kenai Peninsula peaked at 888 mt in 1984 to 1985 and closed in 1997 to 1998. The pot fishery for spot (*P. platyceros*) and coonstriped shrimp (*P. hypsinotus*) in PWS increased rapidly after 1978 to its peak harvest of 132 mt in 1986. This pot fishery then declined to its low of 8 mt in 1991 and has been closed since 1992. The trawl shrimp fishery for northern shrimp in PWS peaked at 586 mt in 1984 and switched to sidestriped shrimp in 1987. The PWS trawl fishery for sidestriped shrimp peaked at 89 mt in 1992, and the northern shrimp catch was virtually zero at this time. The PWS catch of sidestriped shrimp in 1999 was 29 mt and falling. The Kodiak trawl fishery for northern shrimp peaked at 37,265 mt in 1971, and catch thereafter declined to 3 mt in 1997 to 1998. In the Aleutian Islands, shrimp catches after the 1978 season declined precipitously, and the fishery has not rebounded since.

3.10.4 General Research Questions

The following general research questions summarize the scientific questions posed or suggested by Section 3.10:

How can trends in abundance of fish and shellfish species be explained?

- What is the role of large-scale atmospheric forcing in controlling the structure and abundance of marine fish and shellfish communities in the western central GOA ecosystem?
  - Does large-scale atmospheric forcing control the quality of food available to larval fish and shellfish through its influence on the species composition and size distribution of primary producers?
  - How do the rates of recruitment of benthic animals with planktonic larvae respond to mechanisms of transport that may control the distribution of larvae relative to suitable bottom habitat?
  - How do the rates of recruitment of fish species with planktonic larvae respond to mechanisms of transport that may control the distribution of larvae relative to suitable juvenile rearing habitat?
- Are fish species that spawn in the winter favored by periods of early peak production, and species that spawn in the spring and summer favored by periods of delayed production?
- What life history strategies permit the arrowtooth flounder to be so widespread and abundant?

How well are the species composition, relative abundances and trophic structure of fish and shellfish communities understood, based on current sampling methods?

What are the underlying mechanisms whereby climate induces changes in productivity, and whereby fishing induces variations in the ocean production of salmon?

- How can salmon stocks be identified?
- What are the ecological processes in the ocean that control productivity of salmon?
- What are the interannual variations in ocean growth, distribution, and migratory timing of salmon stocks?
- What are the annual levels of ocean production of salmon in the North Pacific and by region of origin?

3.11 Marine Mammals

3.11.1 General Characteristics of the GOA Marine Mammal Fauna

The GOA has a mostly temperate marine mammal fauna. Calkins (1986) provided the only previously published review of GOA marine mammals, and listed 26 species as occurring in the region. Five of those (pilot whale, Risso's dolphin, right whale dolphin, white sided dolphin, and California sea lion) are primarily southern species that occur occasionally in Southeast Alaska but rarely, if at all, in the EVOS region. He also listed the Pacific walrus, which is a subarctic species that occurs in the GOA only as occasional wanderers.

Table 3.9 provides a summary of the general characteristics of 20 marine mammal species that occur regularly in the GEM region, including 7 baleen whales, 8 toothed whales and porpoises, 4 pinnipeds, and the sea otter. Useful reviews of information on these species can be found in Lentfer (1988), Calkins (1986), Perry et al. (1999), Forney et al. (2000), and Ferrero et al. (2000). Various aspects of marine mammal biology are described in detail in Reynolds and Rommel (1999).

Most of the marine mammal species shown in Table 3.9 are widely distributed in the North Pacific Ocean, and the animals that inhabit the GEM region represent only part of the total population. Application of modern molecular genetics techniques, however, has provided much new information on population structures (Dizon et al. 1997). Researchers have found that for species such as killer whales (Hoelzel et al. 1998), beluga whales (O'Corry-Crowe and Lowry 1997), (Bickham et al. 1996), harbor seals (Westlake and O'Corry-Crowe 1997), and sea otters (Scribner et al. 1997), genetic exchange among adjacent and sometimes overlapping groups of animals is so low that they need to be managed as separate stocks.

Taxonomically the GOA marine mammal fauna can be broken down into four major groups:

- Mysticete cetaceans–baleen whales;
- Odontocete cetaceans–toothed whales;
- Pinnipeds–seals, sea lions, and fur seals; and
- Mustelids-sea otters.

The baleen whales are primarily summer seasonal visitors to the GOA that come to the continental shelf and offshore waters to feed on zooplankton and small schooling fishes (Calkins 1986, Perry et al. 1999). Breeding and calving occur in more southerly, warmer, regions. The GOA is primarily a migration route for the gray whale, which breeds and calves in Baja California, Mexico, and has its primary feeding grounds in the northern Bering and Chukchi seas Jones et al. 1984.

Table 3.9 Summary of Characteristics of Marine Mammal Species That Occur Regularly in the GOA EVOS Area

Species shown in bold are those that have been selected as focal species for GEM.

	Use of Gulf of Alaska by Species			Population Status		Management Classification		
Species	**Residence**	**Habitats[1]**	**Activities[2]**	**Abundance[3]**	**Trend**	**EVOS**	**MMPA**	**ESA**
Mysticetes								
Blue whale	seasonal	S, D	F	small?	unknown		depleted	endangered
Fin whale	seasonal	S, D	F	medium?	unknown		depleted	endangered
Sei whale	seasonal	S, D	F	medium?	unknown		depleted	endangered
Humpback whale	seasonal	C, S, D	F	medium	increasing		depleted	endangered
Gray whale	seasonal	C, S	M, F?	large	increasing			
Right whale	seasonal	S	F	small	unknown		depleted	endangered
Minke whale	resident?	C, S	F, C, B?	medium?	unknown			
Odontocetes								
Sperm whale	seasonal?	S, O	F	large?	unknown		depleted	endangered
Killer whale	**resident**	**C, S, D**	**F, C, B**	**small**	**unknown**	**damaged**		
Beluga whale	**resident**	**C, S**	**F, C, B**	**small**	**declining?**		**depleted**	
Beaked whale[4]	resident?	S, D	F, C, B	unknown	unknown			
Dall's porpoise	resident	S, D	F, C, B	large	unknown			
Harbor porpoise	resident	C, S	F, C, B	large	unknown			
Pinnipeds								
Steller sea lion	**resident**	**T, C, S, D**	**F, C, B**	**large**	**declining**		**depleted**	**endangered**
Northern fur seal	seasonal	S, D	M, F	large	stable		depleted	
Harbor seal	**resident**	**T, C, S**	**F, C, B**	**large**	**declining**	**damaged**		
Elephant seal	seasonal	S, D	F	large	increasing			
Mustelids								
Sea otter	**resident**	**T, C, S**	**F, C, B**	**large**	**unknown**	**damaged**		

[1] T = terrestrial; C = coastal; S = continental shelf; D = deep water
[2] F = feeding; M = migrating; C = calving/pupping; B = breeding
[3] small = <1,000; medium = 1,000-10,000; large = >10,000
[4] Probably includes at least 3 species: Baird's beaked whale, Cuvier's beaked whale, and Bering Sea beaked whale

The large species of baleen whales were all greatly reduced by commercial over-exploitation (Perry et al. 1999). Historical information on stock structure and abundance is very limited, and, partly because of their broad distributions, accurately assessing current abundance and population trend is generally difficult (Ferrero et al. 2000). Humpback whales and gray whales are exceptions to that generalization. For humpbacks, estimates of population size based on individual identifications from fluke photos (Calambokidis et al. 1997) suggest that the central North Pacific stock is increasing (Ferrero et al. 2000). For many years, systematic counts have been made of gray whales migrating along the California coast, and results indicate that since the 1960s the population has been increasing by 2.5% per year (Breiwick 1999).

The situation with sperm whales is much like that of the large baleen whales. Many features of their basic biology, such as stock structure, distribution, migratory patterns, and feeding ecology, are poorly known. They occur throughout the North Pacific, mostly in deep water south of 50° N latitude, but some are seen in the northern GOA at least in summer (Calkins 1986, Perry et al. 1999). From what is known of their diet, sperm whales eat mostly deep-water fishes and squids. North Pacific sperm whales were intensely harvested, with more than 250,000 killed during 1947 to 1987 (Perry et al. 1999). Current abundance and population trend are complete unknowns.

In contrast to the baleen whales and sperm whale, the smaller toothed whales are primarily resident in the GOA. Very little is known about the biology of beaked whales, but the other species have been relatively well studied. Two species, killer whales and beluga whales, have been selected as focal species for GEM and are discussed in detail in later sections. Harbor porpoises and Dall's porpoises both have relatively large populations, and with the exception of incidental take in commercial fisheries, they are unlikely to have been significantly impacted by human activities (Ferrero et al. 2000). Both species feed on small fishes and squids, with Dall's porpoises using mostly continental shelf and slope areas and harbor porpoises most common in coastal and continental shelf waters (Calkins 1986).

The two resident pinniped species, Steller sea lions and harbor seals, are both focal species for GEM and will be discussed later in this section. Northern fur seals pup and breed on islands in the Bering Sea (Pribilof Islands and Bogoslof Island). A portion of the population migrates through the GEM region on its way to and from their rookeries. Adult fur seals may feed in the GOA during migration and winter months, and non-breeding animals may feed in the area year-round. Small fishes and squids are the primary foods of fur seals (Calkins 1986). Historically, northern fur seals were depleted by commercial harvests, but the population is now large, numbering about 1 million animals, and currently stable (Ferrero et al. 2000). Northern elephant seals pup and breed at rookeries in California and Mexico. After breeding, adult males go to the GOA to feed on deep-water fishes and cephalopods (Stewart 1997). The northern elephant seal population was greatly depleted by harvesting, but it is currently large and growing (Forney et al. 2000).

The sea otter is a focal species for GEM and is discussed later in this section.

As a group marine mammals are managed and protected by domestic legislation and international treaties that generally do not apply to other marine species (Baur et al. 1999) (see Table 3.9). Early protective efforts were in response to the need to limit commercial harvests and to reduce their impacts on declining and depleted populations. The North Pacific Fur Seal Convention, agreed to in 1911, provided protection to both fur seals and sea otters. In 1946, the International Convention for the Regulation of Whaling began to manage harvests of large whales, and it provided progressive protection to stocks as they became over-exploited. The ESA provides protection to marine mammals (and other species) that may be in danger of extinction because of human activities. The SEA also allows protection of "critical habitat" needed by those species. All species of marine mammals are covered by the Marine Mammal Protection Act (MMPA), which became federal law in 1972. Primary objectives of the MMPA are to "maintain the health and stability of the marine ecosystem," and for each marine mammal species to "obtain an optimum sustainable population keeping in mind the carrying capacity of the habitat." Provisions of the MMPA put a moratorium on all "taking" of marine mammals, with exceptions allowed for subsistence hunting by Alaska Natives, scientific research, public display, commercial fishing, and certain other human activities, subject to restrictions and permitting. Species determined to be below their "optimum sustainable population" level, and those listed as threatened or endangered under provisions of the ESA, are listed as depleted under the MMPA and may be given additional protection. Certain species of marine mammals were determined to have been damaged by the EVOS, and therefore have been subjects of EVOS restoration activities.

Another unique aspect of marine mammal management is the strong involvement of Alaska Natives in the process. Alaska Natives have formed a number of groups that represent their interests in research, management, conservation, and traditional subsistence uses of marine mammals. Groups especially relevant to the EVOS GOA region include the Alaska Native Harbor Seal Commission (ANHSC), the Alaska Sea Otter and Steller Sea Lion Commission, and the Cook Inlet Marine Mammal Council. The ANHSC has been particularly active in the EVOS region, and has received funds from the Trustee Council to conduct a biosampling program in PWS and the GOA, and to contribute information about the distribution, abundance, and health of seals. Congress has recognized the benefits of involving Alaska Natives in marine mammal management, and has included provisions for co-management programs (Alaska Native organizations working as partners with federal management agencies) in the 1994 amendments to the MMPA.

As will be discussed in detail in the following sections, some marine mammal populations have declined in the GOA (and elsewhere in Alaska) in recent years.

In general, the causes of those declines are unclear, but there has been speculation that they may be in some way related to the climactic regime shift that occurred in the region. The evidence supporting such a connection is the temporal coincidence of the shift to a warmer regime, which happened in the mid-1970s, and the decline of harbor seals and Steller sea lions that has occurred in the 1970s through the 1990s.

The National Research Council (NRC) reviewed evidence for a linkage between climate and marine mammal declines as part of their effort to explain changes that have occurred in recent years in the Bering Sea (NRC 1996). They found data that showed some likely negative effects of cold weather on northern fur seal pups (Trites 1990) and a strong influence of warm El Niño conditions on California sea lions (Trillmich and Ono 1991). Because most GOA marine mammals have broad ranges that include waters much warmer than the GOA, it is unlikely that a warmer regime has had any direct negative effect on their reproduction or survival. The warmer conditions, however, have resulted in changes in fish and invertebrate populations (Anderson et al. 1997) that may in turn have affected the nutrition of harbor seals and Steller sea lions (Alaska Sea Grant College Program 1993). The NRC concluded that food limitation was likely a factor in Bering Sea pinniped population declines, but that this was due to a complex suite of biological and physical interactions and not simply the regime shift (NRC 1996).

3.11.2 Focal marine mammal species for the GEM program

3.11.2.1 Killer Whale

Killer whales are medium- sized, toothed whales. They are a cosmopolitan species generally found throughout the world's oceans, but most common in colder nearshore waters (Heyning and Dahlheim 1988). Sightings in Alaska show a wide distribution, mostly on the continental shelf, but also offshore (Braham and Dahlheim 1982). Because there has been no real effort to track individual killer whales, the understanding of movements is based primarily on sightings of animals that can be identified by marks and pigmentation patterns (Bigg et al. 1987). The general pattern seems to be that some killer whales may stay in areas for several months while feeding on seasonally abundant prey, but long-distance movements are not uncommon (Ferrero et al. 2000).

In the GOA, killer whales are seen frequently in Southeast Alaska and the area between PWS and Kodiak (Matkin and Saulitis 1994). Within the EVOS GOA region, whales are seen most commonly in southwestern PWS, Kenai Fiords, and southern Resurrection Bay (Matkin et al. 2000). Whales move back and forth between these areas as well as to and from Southeast Alaska (Matkin et al. 1997). Sightings from the area around Kodiak suggest that killer whales are common, but there has been little study effort devoted to that region (Matkin and Saulitis 1994).

Killer whales have been studied in detail in easily accessible areas such as Washington state, British Columbia, Southeast Alaska, and PWS. Researchers have found that killer whales have a very complex social system and population structure. Studies of association patterns (Matkin et al. 1998), vocalizations (Ford 1991, Saulitis 1993), feeding behavior (Ford et al. 1998), and molecular genetics (Hoelzel et al. 1998, Barrett-Lennard et al. in press) have shown that there are two primary types of killer whales. The types are termed "transient" and "resident." A primary ecological difference between the two types is that residents eat fish, while transients mostly prey on other marine mammals (Ford et al. 1998). Within each of these general types, killer whales are divided into pods that may be composed of one or more matrilineal groups. In resident whales, the pods are very stable through time, with virtually no permanent exchange of individuals between pods, but new pods may be formed by splitting off of a maternal group. A third killer whale type called "offshore" has been encountered, but little is known about them (Ford et al. 1994).

What is known of the life history and biology of killer whales in Alaska was compiled in Matkin and Saulitis (1994). Both females and males are thought to become sexually mature at about 15 years of age. Females may produce calves until they are about 40, at intervals of 2 to 12 years. Mating occurs mostly during May through October, and most births happen between fall and spring. Maximum longevity has been estimated to be 80 to 90 years for females and 50 to 60 years for males. Killer whales have no natural enemies, but in some areas, local abundance and pod structure have been affected by human activities, including live captures for public display, interactions with commercial fisheries, and the EVOS (Olesiuk et al. 1990, Dahlheim and Matkin 1994, Matkin et al. 1994, Ferrero et al. 2000, Forney et al. 2000). Normal birth and death rates for resident killer whales are about 2% per year (Olesiuk et al. 1990).

Surface observations and examination of stomach contents from stranded animals have shown that as a group killer whales can and do eat a wide array of prey, including fishes, birds, and mammals (Matkin and Saulitis 1994). More detailed studies have documented considerable prey specialization in certain pods and individuals. Resident killer whales in the PWS feed mostly on coho salmon during the summer (Matkin et al. 1997) and on chinook salmon in winter and spring (Matkin 2000). Transient whales in the same area eat mostly harbor seals, Dall's porpoise, and harbor porpoise (Saulitis 1993, Matkin and Saulitis 1994). Some GOA transient killer whales occasionally eat Steller sea lions (Barrett-Lennard et al. 1995).

It is difficult to come up with meaningful population estimates for killer whales, partly because they may move over great distances and partly because some groups (such as the offshore type) and areas (such as the GOA west of Resurrection Bay) have been poorly studied. Ferrero et al. (2000) gave a minimum estimate of 717 whales in the northern resident stock of the eastern North Pacific, and Forney et al. (2000) gave a minimum number of 376 for the transient stock of the eastern North Pacific. Reliable data on trend in abundance are not available for either stock. The most recent census (1999) indicates that there are 135 killer whales in the eight pods that regularly use the Kenai Fiords-PWS region (Matkin 2000).

Studies of killer whales in the PWS area began in the late 1970s (von Ziegesar et al. 1986, Leatherwood et al. 1990). Because killer whales were determined to have been damaged by the EVOS, killer whale studies were intensified during 1989 to 2000 (Matkin et al. 1994, 2000). Those long-term studies allow accurate determination of numbers, because all individuals in each pod are photoidentified nearly every year. Births and deaths of individual animals are monitored, which allows the calculation of reproductive and survival rates for each pod (Matkin and Saulitis 1994, Matkin et al. 2000).

Matkin et al. (1999) used association and genealogical data to organize the resident killer whales in the EVOS GOA area into nine pods. Data on the number of whales in each of those pods for the period from 1984 to 2000 are shown in Table 3.10. All resident pods with the exception of AB pod have either increased or stayed the same since 1984. The number of whales in AB pod decreased by 36% from 1988 to 1990 and has stayed about the same since. Since 1990, the recruitment rate for AB pod has been similar to other resident pods, but the mortality rate has been more than twice as high (Matkin et al. 2000).

Less is known about transient killer whales, and their stock structure within the eastern North Pacific is less clear. Stock assessment reports have dealt with all transient whales that occur from Alaska to California as a single stock (Forney et al. 2000). Studies have shown, however, that two groups of whales that occur in the EVOS GOA region, called AT1 transients and GOA transients, are genetically and acoustically distinct from one another and from other west coast transients (Saulitis 1993, Barrett-Lennard et al. in press). GOA transients range widely, but are seen only occasionally in the PWS-Kenai Fiords area. The AT1 pod occurs in the PWS-Kenai Fiords area year-round (Saulitis 1993, Matkin et al. 2000). The number of whales in the AT1 pod has declined by more than 50% since 1988, with only 10 individuals remaining in 2000 (Table 3.10).

The declines in the AB and AT1 killer whale pods are issues of major conservation concern. Thirteen whales, mostly juveniles and adult females, disappeared from AB pod from March 1989 to June 1990, the highest mortality rate ever seen in a resident killer whale pod. Although 12 calves have been born in AB pod since then, there is no clear trend toward recovery because an additional 10 animals have died. For the AT1 transients, 12 whales have died since 1988 and no calves have been recruited to the group since 1984 (Matkin 2000).

Table 3.10 Number of whales Photographically Identified in Killer Whale Pods in the GOA EVOS Area, 1984 to 2000

Pod Identifier	1984	1988	1990	2000
Resident Pods				
AB	35	36	23	25
AD05	13	11	12	13
AD16	6	5	5	6
AE	13	12	13	18
AI	6	6	6	6
AJ	25	26	28	36
AK	7	8	9	11
AN10	12	13	13	20
AN20	23	26	29	[1]
Transient Groups				
AT1	22	22	13	10

Source: Matkin et al. 2000 and (Matkin personal communication)

[1] The entire AN20 pod has not been photographed since 1991.

The causes of the declines in these two killer whale pods are not entirely clear. Killer whales are only rarely caught incidental to commercial fishing operations (Ferrero et al. 2000). In the mid-1980s, however, the AB pod was involved in a different type of interaction with the longline fisheries for sablefish and halibut (Matkin and Saulitis 1994). Whales removed hooked fish from the lines, and fishermen attempted to deter them by shooting at them and detonating explosives. A number of whales were seen with gunshot wounds, and some of those later disappeared. In spite of eight mortalities during the previous 4 years, the pod numbered 36 animals in 1988, one more than in 1984 (Matkin et al. 1994). In March to September 1989, members of the AB pod were several times seen swimming in oil from the EVOS. Although a direct cause-effect relationship cannot be shown, there is reason to believe that the population decline is in some way due to the spill (Dahlheim and Matkin 1994, Matkin et al. 1994). Members of the AT1 transient group were also seen in oil in summer 1989, and many members of the group were missing the following year and have not been seen since (Matkin et al. 1994, 2000). An additional concern related to the potential effects of contact with oil is the consumption of harbor seals, which AT1 transients feed on to a large extent (Saulitis 1993). Because many harbor seals were coated with oil by the spill (Lowry et al. 1994), the whales may have ingested contaminated prey. In addition, the harbor seal population has decreased. Harbor seal numbers were declining in parts of PWS before 1989; an estimated 300 seals were killed by the spill; and the seal population has continued to decline at least through 1997 (Frost et al. 1994, Frost et al. 1999). Therefore, the lack of recruitment into the AT1 pod may be at least partly caused by the severe reduction of harbor seal numbers in the EVOS GOA region (Matkin et al. 2000).

Other than their general status under the MMPA, Alaskan killer whales have not been afforded any special legal protection. Although the AB pod is part of a larger resident population, the AT1 group is a distinct population that is demographically and genetically isolated from other killer whales. For that reason, protective listing under the ESA may be warranted for the AT1 group.

3.11.2.2 Beluga Whale

Belugas, also called white whales or belukhas, are medium-sized, toothed whales. They have a disjunct circumpolar distribution and occur principally in arctic and subarctic waters (O'Corry-Crowe and Lowry 1997). Recent studies have shown that belugas are separated into a number of discrete genetic groups (stocks), that generally correspond to groups of animals that summer in different regions (O'Corry-Crowe et al. 1997, Brown Gladden et al. 1999). There are four relatively large stocks that range throughout western and northern Alaska and a small stock that occurs in Cook Inlet and the GOA (O'Corry-Crowe and Lowry 1997).

In the GOA, belugas are seen most commonly in Cook Inlet, but sightings have been made near Kodiak Island, in PWS, and in Yakutat Bay (Laidre et al. in press). The fact that there have been several reports of belugas in Yakutat Bay during 1976 to 1998 suggests the possibility of a small resident group there. The other sightings have most likely been of animals from the main Cook Inlet concentration.

Because summer surveys of belugas in Cook Inlet have been conducted at irregular intervals since the 1960s and annually since 1993, beluga distribution in that region is fairly well known (Klinkhart 1966, Calkins 1984, Rugh et al. in press). Belugas may be found throughout Cook Inlet, and in mid-summer they are always most common near the mouths of large rivers in Upper Cook Inlet, especially the Beluga River, the Susitna River, and Chickaloon Bay. Other areas where they have been commonly seen include Turnagain Arm, Knik Arm, Kachemak Bay, Redoubt Bay, and Trading Bay. Rugh et al. (in press) compared the distribution of June and July sightings made in the 1990s with earlier years. They found that the proportion of sightings in Upper Cook Inlet has increased greatly in the last decade, and they conclude that the number of sightings in Lower Cook Inlet and in offshore waters has declined during the years.

In February-March 1997, aerial surveys were conducted with the specific goal of gathering information on winter distribution of the Cook Inlet beluga stock (Hansen and Hubbard 1999). The area surveyed included Cook Inlet and parts of the GOA between Kodiak Island and Yakutat Bay. Almost all beluga sightings (150 out of 160) were in the middle part of Cook Inlet, and the remaining sightings were in Yakutat Bay.

Since 1999, the NMFS National Marine Mammal Laboratory (NMML) has gathered data on Cook Inlet beluga distribution and movements through use of satellite-linked tags. In 1999, one whale that was tagged and tracked for 110 days (from May 31 to September 17) stayed in Upper Cook Inlet (Ferrero et al. in press). To try to obtain information on winter distribution, two tags were attached to whales on September 13, 2000. The whales were tracked until mid-January. During that time, they moved around quite a bit in Upper Cook Inlet, but did not go south of Kalgin Island (NMML unpublished data available at http://nmml.afsc.noaa.gov/CetaceanAssessment/Folder/2000_beluga_whale_tagging.htm).

In many parts of Alaska, including Cook Inlet, belugas are most common in nearshore waters during the summer (Calkins 1986, Frost and Lowry 1990). Proposed reasons for the use of nearshore habitats include the possible advantage of warm protected waters for newborn calves (Sergeant and Brodie 1969), facilitation of the epidermal molt by fresh water and rubbing on gravel (St. Aubin et al. 1990, Smith et al. 1992), and feeding on seasonally abundant coastal and anadromous fishes (Seaman et al. 1985, Frost and Lowry 1990). Although there have been no direct studies of the diet of Cook Inlet beluga whales, at least part of the reason for their congregating nearshore and near river mouths must be to feed on abundant fishes such as salmon and eulachon (Calkins 1984, Moore et al. in press).

There has been no life history information collected from Cook Inlet belugas. Biological characteristics of belugas in other areas were reported by Hazard (1988). Females become sexually mature at 4 to 7 years of age and males at 7 to 9 years. Mature females give birth to calves every 2 to 3 years, mostly in late spring or summer. The maximum life span has not been well defined, but is likely to be about 40 years. In the southern part of their range, belugas are preyed upon by killer whales, and in more northern areas by polar bears.

Beluga whales are difficult to enumerate for a number of reasons. Principal problems are that whales are easy to miss in muddy water or when whitecaps are present, and in all conditions some fraction of the population will be underwater where they cannot be seen. Early survey efforts largely ignored these problems and just reported the number of animals counted, which during the 1960s to 1980s was usually a few hundred. In 1994 the NMFS NMML began to produce annual estimates of population size with standardized aerial surveys of the entire Cook Inlet and a sophisticated set of methods to correct for whales that were missed by observers (Hobbs et al. in press, Rugh et al. in press, Hobbs 2000). For each survey, they reported the number of whales counted and an estimate of the total population size (Table 3.11). Unfortunately because of problems inherent in counting whales from the air, the annual estimates are imprecise and have a relatively large coefficient of variation. Nonetheless, regression analysis shows a statistically significant population decline during the 7- year period: The 2000 population is most likely at least one-third smaller than it was in 1994. The 95% confidence limits for the 2000 survey were 279 to 679 whales, meaning it is very likely that the true current population size is somewhere in that range.

Available data suggest that beluga whales in Cook Inlet rarely become entangled in fishing gear (Ferrero et al. 2000). The largest source of mortality in recent years has been hunting by Alaska Natives. Although harvest data are imprecise, estimates of the annual number of whales killed during 1993 to 1998 ranged from 21 to 123 animals (Ferrero et al. 2000, Mahoney and Shelden in press). This compares to a likely sustainable harvest of about 20 whales from a population of 500.

Table 3.11 Counts and Population Estimates for Cook Inlet Beluga Whales, 1993 to 2000

Year	Whale Count	Abundance Estimate	Coefficient of Variation
1994	281	653	0.43
1995	324	491	0.44
1996	307	594	0.28
1997	264	440	0.14
1998	193	347	0.29
1999	217	357	0.20
2000	184	435	0.23

Source: (Hobbs, Rugh, and DeMaster in press)and (Hobbs personal communication). ref.

Because of the population decline and the potential for continued overharvest, several environmental groups and one individual submitted a petition to NMFS in March 1999 requesting that the Cook Inlet beluga whale be listed as an endangered species under the ESA. Responding to the same problems, Senator Ted Stevens inserted language into federal legislation passed in May 1999 that prohibited any hunting of beluga whales by Alaska Natives, unless they had entered into a co-management agreement with NMFS to regulate the hunt. In May 2000, NMFS finalized a designation of depletion under provisions of the MMPA for the Cook Inlet beluga population, and in June 2000, the agency determined that a listing under the ESA was not warranted. There was no legal harvest of Cook Inlet belugas in either 1999 or 2000. NMFS is currently working through provisions of the MMPA to allow a small, regulated take of Cook Inlet belugas to satisfy the cultural needs of Alaska Natives.

Although overharvest by Alaska Natives in the 1990s appears to be sufficient to explain the population decline, concerns that this small isolated population may be vulnerable to other threats remain. Areas of concern that have been identified include commercial fishing, oil and gas development, municipal discharges, noise from aircraft and ships, shipping traffic, and tourism (Moore et al. in press).

3.11.2.3 Steller Sea Lion

Steller sea lions are the largest species of otariid (eared seal). They are distributed around the North Pacific rim from northern Japan, the Kuril Islands and Okhotsk Sea, through the Aleutian Islands and Bering Sea, along the southern coast of Alaska, and south to California (Kenyon and Rice 1961, Loughlin et al. 1984, Loughlin et al. 1992). Most large rookeries are in the GOA and Aleutian Islands. The northernmost rookery, Seal Rocks, is in the EVOS region at the entrance to PWS. Currently the largest rookery is on Lowrie Island, in the Forrester Island complex in southern Southeast Alaska.

Steller sea lions are listed as two distinct population segments under the ESA: an eastern population that includes all animals east of Cape Suckling, Alaska, and a western population that includes all animals at and west of Cape Suckling. This distinction is based mostly on results from mitochondrial DNA genetic studies that found a distinct break in the distribution of haplotypes between locations sampled in the western part of the range and eastern locations, indicating restricted gene flow between two populations (Bickham et al. 1996, Bickham et al. 1998a). Information on distribution, population response, and phenotypic characteristics, also support the concept of two Steller sea lion stocks (Loughlin 1997).

Most adult Steller sea lions occupy rookeries during the pupping and breeding season, which extends from late May to early July (Pitcher and Calkins 1981, Gisiner 1985). Some juveniles and non-breeding adults may summer at or near the rookeries, but most use other locations as haul-outs. During fall and winter, sea lions may be at rookery and haul-out sites that are used during the summer, and they are also seen at other locations. They do not make regular migrations, but do move considerable distances. When they reach adulthood, females generally return to the rookeries of their birth to pup and breed (Kenyon and Rice 1961, Calkins and Pitcher 1982, Loughlin et al. 1984).

Steller sea lions use a number of marine and terrestrial habitats. Adults congregate for pupping and breeding on rookeries that are usually on sand, gravel, cobble, boulder, or bedrock beaches of relatively remote islands. Haul-outs are sites used by adult sea lions during times other than the breeding season, and by non-breeding adults and subadults throughout the year. Haul-outs may be at sites also used as rookeries, or on other rocks, reefs, beaches, jetties, breakwaters, navigational aids, floating docks, and sea ice. With the exception of sea ice, sites used for rookeries and haul-outs are traditional and the specific locations used vary little from year to year. Factors that influence the suitability of a particular area are poorly understood (Gentry 1970, Sandegren 1970, Calkins and Pitcher 1982).

When not on land, Steller sea lions are seen near shore and out to the edge of the continental shelf; in the GOA, they commonly occur near the 200-m depth contour (Kajimura and Loughlin 1988). Studies with using satellite-linked telemetry have provided detailed information on at-sea movements (Merrick and Loughlin 1997). Adult females tagged at rookeries in the central GOA and Aleutian Islands in summer made short trips to sea and generally stayed on the continental shelf. In winter, adult females ranged more widely with some moving to seamounts far offshore. Pups tracked during the winter made relatively short trips to sea, but one moved 320 km from the eastern Aleutians to the Pribilof Islands.

Female Steller sea lions reach sexual maturity at 3 to 6 years of age and most breed annually during June and July (Pitcher and Calkins 1981). Males reach sexual maturity at 3 to 7 years of age and physical maturity by age 10; they establish territories on rookeries during the breeding season, and one male may breed with several females (Thorsteinson and Lensink 1962, Gentry 1970, Sandegren 1970, Gisiner 1985). Territorial males fast for long periods during the pupping and breeding season. Pups are born on land, normally in late May to June, and they stay on land for about 2 weeks, then spend an increasing amount of time in intertidal areas and swimming near shore. After giving birth, sea lion mothers attend pups constantly for about 10 days, then alternate trips to sea for feeding with returns to the rookery to suckle their pup. Unlike most pinnipeds, for which weaning is predictable and abrupt, Steller sea lions may continue to nurse until they are at least three years old (Gentry 1970, Sandegren 1970, Calkins and Pitcher 1982).

Steller sea lions die from a number of causes, including disease, predation, shooting by humans, and entanglement in fishing nets or debris (Merrick et al. 1987). In addition, pups may die from drowning, starvation caused by separation from the mother, crushing by larger animals, and biting by females other than the mother (Orr and Poulter 1967, Edie 1977).

Steller sea lions are generalist predators that mostly eat a variety of fishes and invertebrates (Pitcher 1981, NMFS 2000). Seals, sea otters, and birds are also occasionally eaten (Gentry and Johnson 1981, Pitcher and Fay 1982, Daniel and Schneeweis 1992). Much effort has been devoted to describing the diet of sea lions in the GOA. In the mid 1970s and mid 1980s, the primary food found in sea lion stomachs was walleye pollock. Octopus, squid, herring, Pacific cod, flatfishes, capelin, and sand lance also were consumed frequently (Pitcher 1981, Calkins and Goodwin 1988). In the 1970s, walleye pollock was the most important prey in all seasons, except summer, when small forage fishes (capelin, herring, and sand lance) were eaten more frequently (Merrick and Calkins 1996). Results from examination of scats collected on rookeries and haul-outs in the GOA in the 1990s confirmed that pollock has been overall the dominant prey, with Pacific cod and salmon also important in some months (Merrick et al. 1997, NMFS 2000). The diet of juvenile Steller sea lions has not been studied in detail, but it is known that they eat somewhat smaller pollock than do adults (Frost and Lowry 1986, Calkins 1998). Available data suggest that the average daily food requirement for sea lions is on the order of 5% to 8% of their body weight per day (Kastelein et al. 1990, Rosen and Trites 2000).

Satellite-linked tags attached to sea lions have provided information on the amount of time spent diving and diving depths (Merrick and Loughlin 1997). Adult females in winter spent the most time feeding and dove the deepest, and young of the year spent relatively little time diving to shallow depths. As young of the year matured, foraging effort increased from November to May.

The abundance of Steller sea lions in the western population has decreased greatly since the 1960s, to the extent that the species has been listed as endangered under the ESA. From the mid-late 1970s through 2000, index counts of adults and juveniles for the western population as a whole declined by 83% from 109,880 to 18,193 (NMFS 2000). Declines in the eastern GOA (Seal Rocks to Outer Island) and central GOA (Sugarloaf Island to Chowiet Island) have been of a generally similar magnitude (73% and 87%), but it appears that the decline in the eastern GOA began later than in the western GOA and other regions (Table 3.12). Counts of pups on rookeries have shown similar declines. Modeling and tagging studies have suggested that the proximate cause of the population decline is probably a reduction in survival of juvenile animals (York 1994, Chumbley et al. 1997). Birth rates are also comparatively low (Calkins and Goodwin 1988), which could be a contributing factor. Population viability analysis suggests that if the decline continues at its current rate some rookeries will go extinct in the next 40 to 50 years, and the entire western population could be extinct within 100 to 120 years (York et al. 1996).

Table 3.12 Index Counts of Steller Sea Lions in the Eastern Gulf of Alaska (Seal Rocks to Outer Island) and Western Gulf of Alaska (Sugarloaf Island to Chowiet Island)

Survey Year	Eastern GOA	Central GOA	Western Stock Total
1976	7,053	24,678	109,880[a]
1985	--	19,002	--
1989	7,241	8,552	--
1990	5,444	7,050	30,525
1991	4,596	6,273	29,418
1992	3,738	5,721	27,286
1994	3,369	4,520	24,119
1996	2,133	3,915	22,223
1997	--	3,352	--
1998	--	3,346	20,201
1999	1,952	--	--
2000	1,894	3,177	18,193

Source: author? (1999)and (NMFS 2000).

Dashes indicate no count in that year.

[1] Uses counts in the Aleutian Islands made in 1977 and 1979

A number of factors have been suggested that may have affected the western Steller sea lion population in the past 3 to 4 decades (Merrick et al. 1987, NMFS 1992, NMFS 2000). There is no evidence that patterns of predation, disease, or environmental contaminants have changed sufficiently to have caused such a major decrease in abundance (Loughlin 1998). In the past, many sea lions were killed in commercial harvests, by incidental entanglement in nets, and by shooting to reduce damage to fishing gear and fish depredation (Alverson 1992). That mortality may have played some part in the early stages of the decline, but such killing has been eliminated or greatly reduced and cannot explain the widespread, continuing decline. Subsistence hunting by Alaska Natives occurs at low levels and is not judged to be an important factor overall (Ferrero et al. 2000). Currently the most likely explanation is that sea lions, especially juveniles, are experiencing higher than normal mortality because they are nutritionally limited (Loughlin 1998, NMFS 2000). The nutritional limitation could be caused by environmental changes that have affected sea lion prey species, competition for prey with commercial fisheries, or some combination of the two.

The decline of the western population of Steller sea lions, and the need to recover the population and protect critical habitat as required by the ESA, have been a major conservation issue in recent years (Lowry et al. 1989, Fritz et al. 1995). Actions proposed to facilitate recovery may have substantial effects on commercial fisheries and coastal communities in the GOA and elsewhere (NMFS 2000).

3.11.2.4 Pacific Harbor Seal

Harbor seals are medium-sized, "earless" seals that are widespread in temperate waters of both the North Atlantic and the North Pacific. In the North Pacific, their distribution is nearly continuous from Baja California, Mexico, to the GOA and Bering Sea, through the Aleutian Islands, and to eastern Russia and northern Japan (Shaughnessy and Fay 1977, Hoover-Miller 1994).

Harbor seals are found primarily in the coastal zone where they feed and haul out to rest, give birth, care for their young, and molt. Haul-out sites include intertidal reefs, rocky shores, mud and sand bars, gravel and sand beaches, and floating glacial ice (Hoover-Miller 1994). From the results of satellite tagging studies in PWS, most adult harbor seals are known to use the same few haul-outs for most of the year (Frost et al. 1996, Frost et al. 1997).

Although it is relatively easy to study harbor seals while they are on haul-outs, their distribution and movements at sea are not as well understood. During 1992 to 1997, as part of EVOS restoration studies, satellite-linked depth recorders (SDRs) were attached to seals in PWS to study their at-sea behavior. Analysis of the tracking data from 49 subadult and adult harbor seals indicated that most tagged seals stayed in or near PWS, but some subadults moved 300 to 500 km east and west in the GOA (Frost et al. 2001, Lowry et al. 2001). Virtually all relocations were on the continental shelf in water less than 200 m deep. Most feeding trips for adults went 10 km or less from haul-outs, and juveniles fed mostly within 25 km.

Patterns of diving (effort and depth) varied geographically and seasonally. During 1997 to 1999, SDRs were attached to 27 recently weaned harbor seal pups in PWS. Preliminary analysis of those data (Frost et al. 1998, Lowry and Frost unpublished) did not show any extraordinary movement patterns.

SDRs have also been attached to harbor seals in Southeast Alaska and the Kodiak region. Preliminary results from those tagging efforts have been reported in Small et al. (1997, 1998). The data are currently being analyzed and prepared for publication (Small. R. 2001).

Overall, harbor seals are relatively sedentary and they show considerable fidelity to haul-out sites (Pitcher and McAllister 1981, Frost et al. 1996, Frost et al. 1997). For management purposes, NMFS has delineated three harbor seal stocks in Alaska:

1. The southeast Alaska stock, including animals east and south of Cape Suckling;

2. The GOA stock, including animals from Cape Suckling to Unimak Pass and westward through the Aleutian Islands; and

3. The Bering Sea stock including animals in Bristol Bay and the Pribilof Islands (Ferrero et al. 2000).

During the past several years, an in-depth study of Alaska harbor seal genetics has been conducted by the NMFS Southwest Fisheries Science Center. Preliminary analysis of those data indicate a number of relatively small population units with very limited dispersal among them (O'Corry-Crowe et al. in press), in (Small et al. 1999). Results suggest that within the EVOS area, there are multiple harbor seal stocks that may require individual management attention. NMFS scientists are currently analyzing the molecular genetics data and preparing it for publication. NMFS managers are evaluating those results with the intention of refining stock boundaries for Alaska harbor seals.

Hoover-Miller (Hoover-Miller 1994) summarized available information on Alaska harbor seal biology and life history. Both male and female harbor seals reach sexual maturity at 3 to 7 years old. Adult females give birth to single pups once a year, on land or on glacial ice. In PWS and the GOA, most pupping occurs from mid-May through June. Newborn harbor seals pups are born with their eyes open, with an adult-like coat, and are immediately able to swim. Pups are weaned when they are 3 to 6 weeks old. Once each year in July to September, harbor seals shed their old hair and grow a new coat. During this time, the seals spend more time hauled out than they do at other times. For that reason, the molt period is a good time to count seals to estimate population sizes and trends.

Most information about the diet of harbor seals in PWS and the GOA was collected in the mid-1970s by examination of stomach contents (Pitcher 1980). The major prey overall in both PWS and adjacent parts of the GOA was pollock.

Octopus, capelin, Pacific cod, and herring also are eaten frequently. Stomachs of young seals contained mostly pollock, capelin, eulachon, and herring. As part of EVOS restoration studies, blubber samples from PWS harbor seals have been analyzed for their fatty acid composition to examine their recent diets (Iverson et al. 1997), and (Lowry and Frost unpublished). Initial results showed that herring, pollock, other fishes, and cephalopods (a class of squid and octopi) had been eaten. Seals sampled at the same haul-out had similar fatty acid compositions, suggesting that they had fed locally on similar prey. In contrast, seals sampled from areas as little as 80 km apart had different fatty acid compositions, indicating substantially different diets. Small et al. (1999) have examined scats from harbor seals collected near Kodiak and found mostly remains of sculpins, greenling, sand lance, and pollock.

Known predators of harbor seals include killer whales, Steller sea lions, and sharks. The impact of these predators on harbor seal populations is unknown, but may be significant. In PWS alone, killer whales may eat as many as 400 harbor seals per year (Matkin 2000). The incidence of sharks caught on halibut longlines in the GOA has increased greatly in the last decade (Lowry and Frost unpublished data). The degree to which these sharks prey on harbor seals is unknown, but seal remains have been observed in their stomachs (Matkin 2000).

Before the MMPA, harbor seals were hunted commercially in Alaska, and they were also killed to reduce their predation on commercially important fishes (Hoover-Miller 1994). Such kills, which exceeded 10,000 animals in many years, were largely stopped in 1972. The MMPA allowed fishermen to shoot seals if they were damaging their gear or catch and could not be deterred by other means. A few hundred animals probably were killed annually for that reason during 1973 to 1993. In 1994, the MMPA was amended to require that fishermen use only non-lethal means to keep marine mammals away from their gear.

Harbor seals have been and continue to be an important food and handicraft resource for Alaska Native subsistence hunters in PWS and the GOA. The ADF&G Division of Subsistence estimated the size of the harbor seal harvest annually during 1992 to 1998. The average annual kill during that period was approximately 380 seals in PWS and 360 for Kodiak, Cook Inlet-Kenai, and the south Alaska Peninsula combined (Wolfe and Hutchinson-Scarbrough 1999). About 88% of the seals shot were retrieved, and 12% were struck and lost. Although harvests at individual villages have varied from year to year, regional harvest levels have shown no clear trend.

Harbor seals are sometimes entangled and killed in the gear set by several commercial fisheries that operate in the EVOS GOA region. Ferrero et al. (2000) estimated an average minimum annual mortality of 36 animals for the GOA stock. This figure was an underestimate, because there have not been observer programs for several of the fisheries that are likely to interact with harbor seals.

Some harbor seals were killed by the EVOS, at least in PWS (Frost et al. 1994). In August and September 1989, ADF&G flew aerial surveys of harbor seals in oiled and unoiled areas of central and eastern PWS. Results of those surveys were compared to earlier surveys of the same haul-outs conducted in 1983, 1984, and 1988. Before the EVOS, counts in oiled and unoiled areas of PWS were declining at a similar rate, about 12% per year. From 1988 to 1989, however, there was a 43% decline in counts of seals at oiled sites compared to 11% at unoiled sites. Other studies conducted as part of the EVOS damage assessment program showed that seals in oiled areas became coated with oil (Lowry et al. 1994). Many oiled seals acted sick and lethargic for the first few months after the spill. Tests of bile and tissues showed that oiled seals were metabolizing petroleum compounds (Frost et al. 1994). Microscopic examination indicated that some oiled seals had brain damage that would likely have interfered with important functions such as breathing, swimming, diving, and feeding (Spraker et al. 1994). It was estimated that approximately 300 seals died because of the EVOS (Frost et al. 1994). Hoover-Miller et al. (2000) disputed the mortality estimate of Frost et al. (1994), but they admit that the spill had effects on harbor seals and do not provide an alternative estimate of mortality.

Harbor seals are one of the most common marine mammals in the EVOS GOA region. In 1973, ADF&G estimated there were about 125,000 in this region based on harvest data, observed densities of seals, and the amount of available habitat (Pitcher 1984). The most recent population estimate for the GOA harbor seal stock, derived from intensive aerial surveys conducted by NMFS, is 29,175 (Ferrero et al. 2000). Although the methods used to derive the two estimates were very different and they are not directly comparable, the difference does suggest that a large decline in harbor seal numbers has occurred in the GOA.

Counts at individual haul-outs and along surveys routes established to monitor trends confirm the decline and provide some information on the temporal pattern of changes (Table 3.13). At Tugidak Island (south of Kodiak Island), average molt period counts declined by 85% from 1976 to 1988 (Pitcher 1990), followed by a period of stabilization before a population increase of about 5% per year during 1994 to 1999 (Small et al. 1999). In eastern and central PWS, the number of seals at 25 trend index sites declined by 42% between 1984 and 1988 (Pitcher 1989). Trend counts at index sites have shown that the decline in that part of PWS continued at least through 1997, by which time there were 63% fewer seals than there were in 1984 (Frost et al. 1999). Counts on the PWS trend route were fairly similar in 1994 to 1998 (Table 3.13), suggesting that the decline in that area may have stopped. In the Kodiak trend area, harbor seal counts increased by 5.6% per year during 1993 to 1999 (Small et al. 1999).

Table 3.13 Counts of Harbor Seals at Index Sites in the EVOS GOA Region

Year	Tugidak Island	PWS	Kodiak
1976	5,708	--	--
1977	4,618	--	--
1978	3,781	--	--
1979	3,133	--	--
1982	1,918	--	--
1984	1,469	2,488	--
1986	1,181	--	--
1988	966	1,875	--
1989	--	1,423	--
1990	882	1,282	--
1991	--	1,200	--
1992	820	1,133	--
1993	805	1,126	3,129
1994	800	981	3,478
1995	804	1,126	3,855
1996	819	962	3,322
1997	844	929	3,674
1998	880	1,053	4,247
1999	929		4,876

Source: (Pitcher 1990), (Frost, Lowry, Sinclair, ver Hoef, and McAllister 1994), (Frost et al. unpublished), (Small. R. personal communication). year?

Counts have been adjusted to account for important covariates (see (Frost, Lowry, and ver Hoef 1999), Small et al. in prep.

Mortality of harbor seals caused by people because of fishery interactions, the EVOS, and hunting has been fairly well documented. Each of these causes may be a contributing factor, but it seems unlikely that they could have caused such a widespread and major population decline. Other factors that could be involved in the decline include disease, food limitation, predation, contaminants, and changes in habitat availability. No strong scientific evidence has been produced, however, to suggest that any of these factors has been a primary cause (Sease 1992, Hoover-Miller 1994). A Leslie matrix model for population projection showed that large changes in vital parameters (reproduction and survival) must have occurred to cause the declines in abundance seen in PWS during 1984 to 1989, and that changes in juvenile survival are likely to have the greatest effect on population growth (Frost et al. 1996).

The large decrease in harbor seal abundance in the GOA has been a major concern among scientists, resource managers, Alaska Natives, and the public. After completion of damage assessment, the Trustee Council funded restoration studies to learn about the biology and ecology of harbor seals in the spill area, and to investigate possible causes for the decline (Frost and Lowry 1994, Frost et al. 1995, Frost et al. 1996, Frost et al. 1997, Frost et al. 1998, Frost et al. 1999). At about the same time, Congress began providing funds to ADF&G to be used to investigate causes of the Alaskan harbor seal decline. Those funds were used to initiate harbor seal research programs in Southeast Alaska and the Kodiak area, and to resume long-term studies on Tugidak Island (Lewis 1996, Small et al. 1997, Small 1998, Small et al. 1999, Small and Pendleton 2001). A major part of all those studies has been live-capturing seals and attaching SDRs to them to learn about their movements, foraging patterns, and behavior on land and at sea. As part of the field studies, researchers have weighed and measured each seal, and have taken samples for studies of blood chemistry, disease, genetics, and diet. Some parts of those studies have been completed and published; some are in the analysis and reporting stage; and others are ongoing. As discussed above, the results have added greatly to the understanding of harbor seals in this area and will continue to do so as more of the work is completed.

Any time a wildlife population declines, it is a cause for concern. For harbor seals in PWS and the GOA, however, the concern is magnified because the causes for the decline are unknown and because these seals are an important food and cultural resource of Alaska Natives. In addition, the results of genetics studies are showing very limited dispersal between seals in adjacent areas, suggesting that harbor seals should be managed as a number of relatively small units. So far GOA harbor seals have not been listed as depleted under the MMPA or as threatened or endangered under the ESA. The listing status could change if recovery doesn't happen in some genetically discrete population units.

Harbor seals may have great value as an indicator species of environmental conditions in the GEM region. They are important in the food web, both as upper level predators on commercially exploited fishes and other fishes and invertebrates, and also as a food resource for killer whales and Alaska Native hunters. Because they are non-migratory and have low dispersal rates, changes in their abundance and behavior should be reflective of changes in local environmental conditions in the areas they inhabit. Further, they are relatively easy to study, and during the past 30 years a considerable amount of baseline data has been collected on their abundance, distribution, and other aspects of their biology and ecology.

3.11.2.5 Sea Otter

Sea otters are the only completely marine species of the aquatic lutrinae, or otter subfamily of the family Mustelidae. They occur only in coastal waters around the North Pacific rim, from central Baja California, Mexico, to the northern Islands of Japan. The northern distribution of sea otters is limited by the southern extent of winter sea ice that limits access to foraging habitat (Kenyon 1969, Riedman and Estes 1990). Southern range limits are less well understood, but are likely related to reduced productivity at lower latitudes, increasing water temperatures, and thermoregulatory constraints imposed by the sea otter's dense fur.

Three subspecies of sea otters are recognized: *Enhydra lutris lutris* from Asia to the Commander Islands of Russia, *E. l. kenyoni* from the western Aleutians to northern California, and *E .l. nereis*, south of the Oregon (Wilson et al. 1991). The subspecific taxonomy suggested by morphological analyses is largely supported by subsequent molecular genetic data (Cronin et al. 1996, Scribner et al. 1997). The distribution of mitochondrial DNA haplotypes suggests little or no recent female-mediated gene flow among populations. Populations separated by large geographic distances, however, share some haplotypes (for example, in the Kuril and Kodiak islands), suggestive of common ancestry and some level of historical gene flow. The differences in genetic markers among contemporary sea otter populations likely reflect the following:

- Periods of habitat fragmentation and consolidation during Pleistocene glacial advance and retreat;
- Some effect of reproductive isolation over large spatial scale; and
- The recent history of harvest-related reductions and subsequent recolonization (Cronin et al. 1996, Scribner et al. 1997).

Sea otters occupy and use only coastal marine habitats. The seaward limit of their feeding habitat, which is about the 100-m depth contour, is defined by their ability to dive to the sea floor. Although sea otters may be found at the surface in deeper water, either resting or swimming, they must maintain relatively frequent access to shallower depths where they can feed. In PWS, 98% of the sea otters are found in water with depths less than 200 m and sea otter abundance is inversely correlated with water depth, with about 80% of the animals observed in water less than 40 m deep (Bodkin and Udevitz 1999). Sea otters forage in diverse bottom types, from fine mud and sand to rocky reefs. Although they may haul out on intertidal or supratidal shores, no aspect of their life history requires leaving the ocean. Where present, surface-canopy-forming kelps provide preferred resting habitat. In areas lacking kelp canopies, sea otters rest in groups or alone in open water, but may select areas protected from large waves where available. Sea otters generally feed alone and often rest in groups of 10 or fewer, but also occur in groups numbering in the hundreds (Riedman and Estes 1990).

Relatively few data are available to describe relations between sea otter densities and habitat characteristics. Maximum sea otter densities of about 12 per square kilometer (km^2) have been reported from the Aleutian and Commander islands (Kenyon 1969, Bodkin et al. 2000) where habitats are largely rocky. Maximum densities in Orca Inlet of PWS, a shallow soft-sediment habitat, are about 16 per km^2. Equilibrium, or sustainable densities ,likely vary among habitats, with reported values of about 5 to 8 per km^2. In PWS, sea otter densities vary among areas, averaging about 1.5 per km^2 and ranging from fewer than 1 to about 6 per km^2 (Bodkin and Udevitz 1999, USGS unpublished data).

The sea otter is the largest mustelid, with males considerably larger than females. Adult males attain weights of 45 kg and total lengths of 148 cm. Adult females attain weights of 36 kg and total lengths of 140 cm. At birth, pups weigh about 1.7 to 2.3 kg and are about 60 cm in total length.

Adult male sea otters gain access to estrous females by establishing and maintaining territories from which other males are excluded (Kenyon 1969, Garshelis et al. 1984, Jameson 1989). Male territories vary in size from about 20 to 80 hectares. Territories may be located in or adjacent to female resting or feeding areas or along travel corridors between those areas, and are occupied continuously or intermittently through time (Loughlin 1981, Garshelis et al. 1984, Jameson 1989). Female sea otters attain sexual maturity as early as age 2, and by age 3 most females are sexually mature. Where food resources may be limiting population growth, sexual maturation may be delayed to 4 to 5 years of age.

Adult female reproductive rates range from 0.80 to 0.94 (Siniff and Ralls 1991, Bodkin et al. 1993, Jameson and Johnson 1993, Riedman et al. 1994, Monson and DeGange 1995, Monson et al. 2000b). Among areas where sea otter reproduction has been studied, reproductive rates appear to be similar despite differences in resource availability. Although copulation and subsequent pupping can take place at any time of year, there appears to be a positive relation between increasing latitude and reproductive synchrony (occurring simultaneously). In California, pupping is weakly synchronous to nearly uniform across months; in PWS, a distinct peak in pupping occurs in late spring.

Reproductive output remains relatively constant across a broad range of ecological conditions, and pup survival appears to be influenced by resource availability, primarily food. At Amchitka Island, a population at or near equilibrium density, dependent pup survival ranged from 22% to 40%, compared to nearly 85% at Kodiak Island, where food was not limiting and the population was increasing (Monson et al. 2000b). Post-weaning annual survival is variable among populations and years, ranging from 18% to nearly 60% (Monson et al. 2000b). Factors affecting survival of young sea otters, rather than reproductive rates, may be important in ultimately regulating sea otter population size. Survival of sea otters more than 2 years of age is generally high, approaching 90%, but gradually declines through time (Bodkin and Jameson 1991, Monson et al. 2000b). Most mortality, other than human related, occurs during late winter and spring (Kenyon 1969, Bodkin and Jameson 1991, Bodkin et al. 2000). Maximum ages, based on tooth annuli, are about 22 years for females and 15 years for males.

Although the sex ratio before birth (fetal sex ratio) is one to one (Kenyon 1982, Bodkin et al. 1993), sea otter populations generally consist of more females than males. Age-specific survival of sea otters is generally lower among males (Kenyon 1969, Kenyon 1982, Siniff and Ralls 1991, Monson and DeGange 1995, Bodkin et al. 2000), resulting in a female-biased adult population

The sea otter relies on air trapped in the fur for insulation and an elevated metabolic rate to generate internal body heat. To maintain the elevated metabolic rate, energy intake must be high, requiring consumption of prey equal to about 20% to 33 % of their body weight per day (Kenyon 1969, Costa 1982).

The sea otter is a generalist predator, known to consume more than 150 different prey species (Kenyon 1969, Riedman and Estes 1990, Estes and Bodkin in press). With few exceptions, their prey generally consist of sessile or slow moving benthic invertebrates such as mollusks, crustaceans, and echinoderms. Preferred foraging habitat is generally in depths less than 40 m (Riedman and Estes 1990), although studies in southeast Alaska have found that some animals forage mostly at depths from 40 to 80 m. A sea otter may forage several times daily, with feeding bouts averaging about 3 hours, separated by periods of rest that also average about 3 hours. Generally, the amount of time a sea otter allocates toward foraging is positively related to sea otter density and inversely related to prey availability. Time spent foraging may be a meaningful measure of sea otter population status (Estes et al. 1982, Garshelis et al. 1986).

NOTE TO PHIL from Lloyd: Latin names of prey weren't given in the other sections – take them out of here?? This is an editorial decision that impacts all sections, so it can wait. An author may choose to put Latin binomials in the text, or put them in Appendix as additions to Appendix A.

Although the sea otter is known to prey on a large number of species, only a few tend to predominate in the diet, depending on location, habitat type, season, and length of occupation. The predominately soft-sediment habitats of Southeast Alaska, PWS, and Kodiak Island support populations of clams that are the primary prey of sea otters. Throughout most of Southeast Alaska, burrowing bivalve clams (species of *Saxidomus, Protothaca, Macoma, and Mya*) predominate in the sea otter's diet (Kvitek et al. 1993). They account for more than 50% of the identified prey, although urchins (*S. droebachiensis*) and mussels (*Modiolis modiolis, Musculus* spp.) can also be important. In PWS and at Kodiak Island, clams account for 34% to 100% of the otter's prey (Calkins 1978, Doroff and Bodkin 1994, Doroff and DeGange 1994). Mussels (*Mytilus trossulus*) apparently become more important as the length of occupation by sea otters increases, ranging from 0% at newly occupied sites at Kodiak to 22% in long-occupied areas (Doroff and DeGange 1994). Crabs (*C. magister*) were once important sea otter prey in eastern PWS, but apparently have been depleted by otter foraging and are no longer eaten in large numbers (Garshelis et al. 1986). Sea urchins are minor components of the sea otter diet in PWS and the Kodiak archipelago. In contrast, the sea otter diet in the Aleutian, Commander, and Kuril islands is dominated by sea urchins and a variety of fin fish (including hexagrammids, gadids, cottids, perciformes, cyclopterids, and scorpaenids) (Kenyon 1969, Estes et al. 1982). Sea urchins tend to dominate the diet of low-density sea otter populations, whereas fishes are consumed in populations near equilibrium density (Estes et al. 1982). For unknown reasons, sea otters in regions east of the Aleutian Islands rarely consume fish.

Sea otters also exploit episodically abundant prey such as squid (*Loligo* spp.) and pelagic red crabs (*Pleuroncodes planipes*) in California and smooth lumpsuckers (*Aptocyclus ventricosus)* in the Aleutian Islands. On occasion, sea otters attack and consume sea birds, including teal (*Anas crecca*), scoters (*Melanita perspicillata*), loons (*Gavia immer*), gulls (*Larus* spp.), grebes (*Aechmophoru soccidentalis*), and cormorants (*Phalacrocorax* spp.) (Kenyon 1969, Riedman and Estes 1990).

Sea otters are known for the effects their foraging has on the structure and function of nearshore marine communities. They provide an important example of the ecological "keystone species" concept (Power et al. 1996). In the absence of sea otter foraging during the 20th century, populations of several species of urchins (*Strongylocentrotus* spp.) became extremely abundant. Grazing activities of urchins effectively limited kelp populations, resulting in deforested areas known as "urchin barrens" (Lawrence 1975, Estes and Harrold 1988). Because sea urchins are a preferred prey item, as otters recovered, they dramatically reduced the sizes and densities of urchins, as well as other prey such as mussels, *Mytilus* spp. Released from the effects of urchin-related herbivory, populations of macroalgae responded, resulting in diverse and abundant populations of under-story and canopy-forming kelp forests. Although other factors, both non-living (abiotic) and living (biotic), can also limit sea urchin populations (Foster and Schiel 1988, Foster 1990), the generality of the sea otter effect in reducing urchins and increasing kelp forests is widely recognized (reviewed in Estes and Duggins 1995). Further cascading effects of sea otters in coastal rocky subtidal communities may stem from the proliferation of kelp forests. Following sea otter recovery, kelp forests provide food and habitat for other species, including fin fish (Simenstad et al. 1978, Ebeling and Laur 1998), which provide forage for other fishes, birds, and mammals. Furthermore, where present, kelps provide the primary source of organic carbon to the nearshore marine community (Duggins et al. 1989).

Effects of sea otter foraging are also documented in rocky intertidal and soft-sediment marine communities. The size-class distribution of mussels was strongly skewed toward animals with shell lengths smaller than 40 mm where otters were present; however, mussels with shell lengths larger than 40 mm comprised a large component of the population where sea otters were absent (VanBlaricom. 1988). In soft-sediment coastal communities, sea otters forage on epifauna (crustaceans, echinoderms, and mollusks) and infauna (primarily clams). They generally select the largest individuals. These foraging characteristics cause declines in prey abundance and reductions in size-class distributions, although the deepest burrowing clams (such as, *Tresus nuttallii* and *Panopea generosa*) may attain refuge from some sea otter predation (Kvitek and Oliver 1988, Kvitek et al. 1992). Community level responses to reoccupation by sea otters are much less well studied in soft-sediment habitats that dominate much of the North Pacific, and additional research is needed in this area.

A century ago, sea otters were nearly extinct, having been reduced from several hundred thousand individuals, by a multi-national commercial fur harvest. They persisted largely because they became so rare that, despite exhaustive efforts, they were only seldom found (Lensink 1962). Probably less than a few dozen individuals remained in each of 13 remote populations scattered between California and Russia (Kenyon 1969, Bodkin and Udevitz 1999). By about 1950, it was clear that several of those isolated populations were recovering. Today, more than 100,000 sea otters occur throughout much of their historic range (Table 3.14), although suitable unoccupied habitat remains in Asia and North America (Bodkin and Kenyon in press).

Trends in sea otter populations today vary widely from rapidly increasing in Canada, Washington, and Southeast Alaska, to stable or changing slightly in PWS, the Commander Islands and California, to declining rapidly throughout the entire Aleutian archipelago (Estes et al. 1998, Estes and Bodkin in press). Rapidly increasing populations sizes are easily explained by abundant food and space resources, and increases are anticipated until those resources become limiting. Relatively stable populations can be generally characterized by food limitation and birth rates that approximate death rates. The recent large-scale declines in the Aleutian archipelago are unprecedented in recent times and demonstrate complex relations between coastal and oceanic marine ecosystems (Estes et al. 1998). The magnitude and geographic extent of the Aleutian decline into the GOA are unknown, but the PWS population appears relatively stable. The view of sea otter populations has been largely influenced by events in the past century when food and space where generally unlimited. As food and space become limiting, however, it is likely that other mechanisms, such as predation, contamination, human take, or disease will play increasingly important roles in structuring sea otter populations.

Table 3.14 Recent Counts or Estimates of Sea Otter (*Enhydra lutris*) Abundance in the North Pacific

Subspecies	Area	Year	Number	Status
E.l. lutris	Russia	1995-97	21,500	Stable in Kurils and Commander islands, increasing in Kamchatka
E.l. kenyoni	Alaska, USA	1994-99	100,000	Declining in Aleutians, uncertain in GOA and increasing in Southeast
	British Columbia, Canada	1997	1,500	Increasing
	Washington, USA	1997	500	Increasing
E.l. nereis	California, USA	1997	2,200	Uncertain
Total			125,700	

Source: (Bodkin and Kenyon in press).

A number of predators include sea otters in their diet, most notably the white shark (*Carcharadon charcharias*) and the killer whale (*Orca orcinus*). Bald eagles (*Haliaeetus leucocephalus*) may be a significant source of very young pup mortality. Terrestrial predators, including wolves (*Canis lupus*), bears (*Ursus arctos*), and wolverine (*Gulo gulo*) may kill sea otters when they come ashore, although such instances are likely rare. Before the work of Estes et al. (1998) predation was thought to play a minor role in regulating sea otters (Kenyon 1969).

Pathological disorders related to enteritis and pneumonia are common among beach-cast carcasses and may be related to inadequate food resources, although such mortalities generally coincide with late winter periods of inclement weather (Kenyon 1969, Bodkin and Jameson 1991, Bodkin et al. 2000). Non-lethal gastrointestinal parasites are common, and lethal infestations are occasionally observed. Among older animals, tooth wear can lead to abscesses and systemic infection, eventually contributing to death.

Contaminants are of increasing concern in the conservation and management of sea otter populations throughout the North Pacific. Concentrations of organochlorines, similar to levels causing reproductive failure in captive mink (*Mustela vison*), occurred in the Aleutian Islands and California, whereas otters from Southeast Alaska were relatively uncontaminated (Estes et al. 1997, Bacon et al. 1998). Elevated levels of butyltin residues and organochlorine compounds have been associated with sea otter mortality caused by infectious disease in California (Kannan et al. 1998, Nakata et al. 1998). Changes in stable lead isotope compositions from pre-industrial and modern sea otters in the Aleutians reflect changes in the sources of lead in coastal marine food webs. In pre-industrial samples, lead was from natural deposits; in contemporary sea otters, lead is primarily from Asian and North American industrial sources (Smith et al. 1990).

Susceptibility of sea otters to oil spills, largely because of the reliance on their fur for thermoregulation, has long been recognized (Kenyon 1969, Siniff et al. 1982) and this was confirmed by the EVOS. Accurate estimates of acute mortality resulting from the EVOS are not available, but nearly 1,000 sea otter carcasses were recovered in the months following the spill (Ballachey et al. 1994). Estimates of carcass recovery rates ranged from 20% to 59% (DeGange et al. 1994, Garshelis 1997), indicating mortality of up to several thousand animals (Ballachey et al. 1994). Sea otter mortality in areas where oil deposition was heaviest and persistent was nearly complete, and through at least 1997, sea otter numbers had not completely recovered in those heavily oiled areas (Bodkin and Udevitz 1994, Dean et al. 2000). Long-term effects include reduced sea otter survival for at least a decade following the spill (Monson et al. 2000a), likely a result of sublethal oiling in 1989, chronic exposure to residual oil in the years following the spill, and spill-related effects on invertebrate prey populations (Ballachey et al. 1994, Fukuyama et al. 2000, Peterson 2000). As human populations increase, exposure to acute and chronic environmental contaminants will likely increase. Improved understanding of the effects of contaminants on keystone species, such as sea otters, may be valuable in understanding how and why ecosystems change.

Human activities contribute to sea otter mortality throughout the Pacific Rim. Incidental mortality occurs in the course of several commercial fisheries. In California, an estimated annual take of 80 sea otters in gill and trammel nets, out of a population numbering about 2,000, likely contributed to a lack of population growth during the 1980s (Wendell et al. 1986). Developing fisheries and changing fishing techniques continue to present potential problems to recovering sea otter populations. In Alaska, sea otters are taken incidentally in gillnet, seine, and crab trap fisheries throughout the state, but total mortality has not been estimated (Rotterman and Simon-Jackson 1988). Alaska Natives are permitted to harvest sea otters for subsistence and handicraft purposes. The harvest is largely unregulated and exceeded 1,200 in 1993, with most of that from a few, relatively small areas. In addition, an illegal harvest of unknown magnitude continues throughout much of the geographic range of sea otters.

Sea otters occupy an important, and well documented, position as an upper-level predator in nearshore communities of the North Pacific. In contrast to most marine mammals that are part of a plankton and fish trophic web, sea otters rely almost exclusively on benthic invertebrates. Because both sea otters and their prey are resources.

Relatively little work has been conducted in investigating relations between those physical and biological attributes that contribute to variation in productivity of nearshore marine invertebrates, such as the clams, mussels, and crabs that sea otters consume, and how that variability in productivity translates into variation in annual sea otter survival. Given the observed variation in sea otter survival, and the recognized role of food in regulating sea otter populations, understanding these relations would provide some empirical measure of the relative contributions of "top-down" (predation) versus "bottom-up" (primary production) factors in structuring nearshore marine communities.relatively sedentary, please correct preceding text they integrate physical and biological attributes of the ecosystem over small spatial scales. Further, both sea otters and their prey occur nearshore, allowing accurate and efficient monitoring of sea otters, their prey, and physical and biological ecosystem attributes. This suite of factors offers a strong foundation for understanding mechanisms, and interactions among factors that regulate long-lived mammalian populations. Given that many populations of large carnivorous mammals are severely depleted worldwide, such an understanding would likely be broadly applicable to conservation and management of natural

3.11.3 General Research Questions

What are the factors responsible for the decline of marine mammal populations?

- What is the role of marine mammal predation (consumption) in structuring their prey populations (plankton, fish, and mammals)?

- What is the relation between abundance of marine mammal populations to the availability and quality of prey species?
- What is the relation between abundance of marine mammal populations and the removals of prey species by fishing?
- What is the relation between reproduction and abundance of marine mammal populations and contaminant burdens?
- How does variation in the amount of food produced affect the geographic distributions, fecundities and survivals of marine mammal populations?

What are the factors responsible for regulation of population size in sea otters?

- Can availability of food become limiting?
- Can predation, contamination, human take, or disease play important roles in structuring sea otter populations?

3.12 General Research Questions

3.12.1 Introduction

Organizing the research questions posed by the individual disciplines represented in this chapter is the first step in building the interdisciplinary team approach that GEM hopes to foster, as explained in Chapter 6, Volume I. Accordingly, the general research questions have been organized to emphasize the need for scientists from different disciplines to work together to understand how the GOA works. As explained more fully in the conceptual foundation discussion (Chapter 4, Volume II), the GEM program is to be built around the questions of how interannual and longer-period trends in the production and distribution of valued marine resources in the northern GOA reflect cycles in the meteorology, the underlying oceanography of the region, and the influences of man on the dynamics and structure of the ecosystem.

3.12.2 General Research Questions

The following general research questions are organized under three major lessons from the scientific background. Aspects important to detecting and understanding changes in all plant and animal species are covered here, although not all species are mentioned by name.

3.12.2.1 The Importance of Weather

Patterns in current structure, upwellings and convergences, temperature, salinity, and density in the waters of the northern GOA are established in response to strong external meteorological conditions affecting the subarctic region of the North Pacific Ocean and through interactions with the coastal topography and the bathymetry of the shelf and coastal regions.

a. How variable–seasonally and annually–are the cross-shelf and along-shore flows over the shelf and inner coastal regions?

b. Under what oceanographic conditions are shelf eddies formed, what are their sizes and how long do they persist?

c. How are seasonal and interannual cycles in upper-layer stability influenced by the conditions of strong or weak Aleutian Low pressure systems?

d. How frequently are deep bottom waters in coastal fjords renewed, and how is this process related to climate forcing on seasonal, annual and longer time scales?

e. Under what conditions, where, and during which seasons are oceanographic frontal regions formed in the northern GOA? How are these regions affected by swings in the strength of the Aleutian Low Pressure system?

3.12.2.2 The Importance of Nutrient Transport

Primary productivity in the euphotic zone is controlled by amounts and supply rates of inorganic nutrients. The deep waters of the GOA contain some of the highest nutrient concentrations found anywhere. However, the seasonally permanent pycnocline between 110 and 150 m generally restricts deep mixing and access to this valuable pool.

a. How do shelf and coastal eddies, frontal regions and areas of upwelling and convergences affect the supply of inorganic nutrients to the upper layers under different conditions of ocean climate in the GOA?

b. What are the processes by which deep and shallow coastal waters become enriched with nutrients each year? How are nutrient renewal processes influenced by the broader climate-forced oceanography of the GOA?

c. What role does the input of fresh water along the northern coastline play in supplying nutrients and influencing recycling from deeper waters? How is this role affected by varying ocean climate on seasonal, annual, and longer time scales?

d. How important and under what oceanographic and meteorological conditions are marine-derived nutrients brought into coastal watersheds and incorporated in the coastal ecology?

e. What are the conditions that provide sufficient nutrient resupply to the surface waters in the fall to promote a fall plankton bloom?

f. How does winter/early spring physical "preconditioning" of the upper layers promote or constrain plankton production through control of nutrient supply rates and photosynthesis in oceanic, shelf, and coastal waters?

g. How is the energy of the diurnal tides used to promote nutrient resupply in the surface waters at selected locations in the northern GOA?

3.12.2.3 The Importance of Plankton Dynamics

In the northern GOA, open ocean and shelf/coastal plankton communities differ in their species composition and annual production. By definition, deep and shallow currents distribute the plankton, and standing stocks occurring at specific times and places are the result of local productivity and the addition or dilution of stocks by advection.

a. Under what physical conditions and to what extent does the oceanic plankton community invade the shelf environment, including the coastal and inside waters? What role does the intruding plankton play in the ecology of the coastal waters?

b. What is the biological nature of the boundary between the oceanic and shelf pelagic ecosystems, and how is the primary and secondary productivity in these regions phased through time and influenced by the state of the Aleutian Low?

c. How is the efficiency of food-web transfer from plankton to fishes, birds, and mammals influenced by varying levels of the dominant macrozooplankton, including large calanoids, euphausiids, and amphipods?

d. How is the time-varying spatial distribution of the dominant zooplankton reflected in seasonal, annual, and longer-period patterns in eddy formation, frontal regions, convergences/divergences, and cross-shelf and along-shore flows?

e. What are the interacting physical and biological processes that establish levels of recruitment in plankton and nearshore benthic communities? How do these processes vary under different conditions of the Aleutian Low pressure system?

f. How can the effects of human influences on the near-shore benthos be distinguished from natural perturbations?

3.12.2.4 The Importance of Trophic Dynamics

The transfer of energy in food webs (trophic dynamics) supporting fishes, birds, and mammals is influenced by the composition of the forage and its quality and availability. The behaviors of forage species that result in seasonal swarming/schooling or layering provide enhanced opportunities for food web transfers. External factors like fishing, hunting, and contaminant levels may significantly affect population structure and size, thereby altering food webs.

a. How does the species composition and quantity of small schooling fishes in shelf and coastal habitats reflect the state of the cycling ocean climate in the northern GOA?

b. In what way do the conditions that favor the concentration of forage species also favor their levels of productivity?

c. How do fluctuations in abundance and species composition of forage stocks and higher level consumers reflect their unique life history strategies under different conditions of ocean climate–winter, spring, andsummer spawners?

d. How does interspecific competition for food resources among forage fishes affect their distributions and rates of production?

e. How does the distribution and abundance of forage species reflect losses to predators?

f. How do climate-forced shifts in the species composition and abundance of forage species control seabird populations?

g. How can the influences of prey availability on seabird abundance be separated from the effects of regional scale properties unique to colony locations, like glaciers?

h. What is the relationship between commercial fishing and the abundance of seabird populations?

i. Do local trends in the abundance of murres and kittiwakes reflect mesoscale or regional scale climate and oceanographic processes affecting prey availability?

j. To what extent are fish, seabird, and mammal stocks affected by top down influences, including fishing and other harvest practices?

k. How is the recruitment to fish and shellfish stocks with pelagic eggs and larvae influenced by variable transport processes connecting with nursery areas?

l. How do climate-influenced transport mechanisms influence the distributions of the drifting larvae of benthic populations relative to suitable settlement substrates?

m. What life history strategies or other population characteristics of arrowtooth flounder cause this species to be so abundant and widespread?

n. How well are the species composition, relative abundance. and trophic structure of fish and shellfish communities understood based on current sampling and analysis procedures?

o. How can long-term trends in salmon production be explained by climate-induced changes in ocean productivity and variations in fishing?

p. How is salmon production controlled by ecological processes in the ocean? How can individual stocks be identified?

q. How variable is the ocean growth, migratory timing and distribution of salmon, and how is this related to aspects of ocean climate?

r. What are the annual levels of ocean production of salmon by region of origin?

s. How is the abundance and distribution of marine mammals related to the availability of forage stocks?

t. How is he abundance of marine mammal populations related to the removals of prey by fishing?

u. How is the abundance of marine mammal populations related to the body burden of marine contaminants?

v. Which life history stages of fishes, seabirds and marine mammals are most at risk to climate change and which to human influences?

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4. CONCEPTUAL FOUNDATION

In This Chapter

- Explanation and role of the conceptual foundation
- Description of leading GOA hypotheses
- Identification and interaction of principal marine ecological concepts
- Description of the central hypothesis and question

4.1 Introduction

The conceptual foundation is a working model, summed up in the form of a hypothesis and question, of how the marine ecosystems in the GOA produce biological resources. The conceptual foundation does not provide a specific testable hypothesis for ecosystem change because doing so might lead to taking too narrow a view of the system in the face of tremendous uncertainty about sources of long-term changes. Instead, this chapter reviews some basic assumptions about production in the oceans, presents a number of hypotheses about how various natural and human forces interact to cause change, discusses the changes in forcing and ecosystem components in various habitat types and regions in the northern GOA and then presents an overarching hypothesis about sources of change—the central hypothesis and questions. Through synthesis and further insight from ongoing programs, in time a conceptual model for the program may eventually be specified. This model should be broad and robust enough to be tested by the monitoring and research program and then accepted, modified, or eventually rejected without making the underlying data streams irrelevant to the contraction of a clearer picture of sources of change to the ecosystem.

This chapter addresses the following topics:

1. The role of the conceptual foundation in the GEM program.
2. Current hypotheses about how multi-annual and multi-decadal changes in natural and human use factors may produce long-term changes in populations of valued animals.
3. Some principal ecological concepts of marine ecosystems that explain generally how natural forces and human activities affect populations of organisms and biodiversity in marine ecosystems.

4. Particular conditions in the GOA that appear to affect ecosystem production patterns across habitats–from the coastal watersheds to the central GOA. Examples of these conditions are large inputs of nutrient-poor fresh water, strong atmospheric low pressure in winter, persistent coastal downwelling, and the presence of gyres and eddies.

The conceptual foundation focuses on how the marine ecosystem in the GOA works.

5. Regional ecological differences, such as those between PWS and Lower Cook Inlet, which may arise as a result of local differences in the interaction between physical forces (tides, winds, and currents), geography, oceanography, and human activities.

6. The conceptual foundation summarized in a central hypothesis and question, applied across four habitat types.

4.2 Role of the Conceptual Foundation in GEM

The conceptual foundation carries the information in the mission, goals, and historical record forward into the other GEM program elements and activities (Figure 4.1). Building on the mission and goals established by the Trustee Council, the foundation encapsulates the Trustee Council's understanding of how the GOA operates as an ecological system and how its biological resources, including highly valued populations of animals, are regulated. Therefore, the conceptual foundation is at the philosophical and scientific center of the GEM program.

The conceptual foundation is the product of ongoing synthesis and modeling, the latest scientific information, and an assessment of leading ecological hypotheses. The central hypothesis and question summarize the current understanding of what controls changes in productivities of biological resources. The conceptual foundation is not intended to be static; it will change as the understanding of the GOA marine ecosystem changes and will better reflect the realities of nature and the role humans play in the ecosystem. Therefore, the conceptual foundation is an integral element in the adaptive management of the GEM program and in marine science.

In summarizing these ideas, the conceptual foundation provides a model of reality. Testing this model requires framing the hypotheses and questions that are the foundation for any monitoring and research program. The intellectual framework of the GEM program is a hierarchy composed of a central hypothesis and question related to habitat types, specific questions for each habitat type, and ultimately, testable hypotheses based on the specific questions.

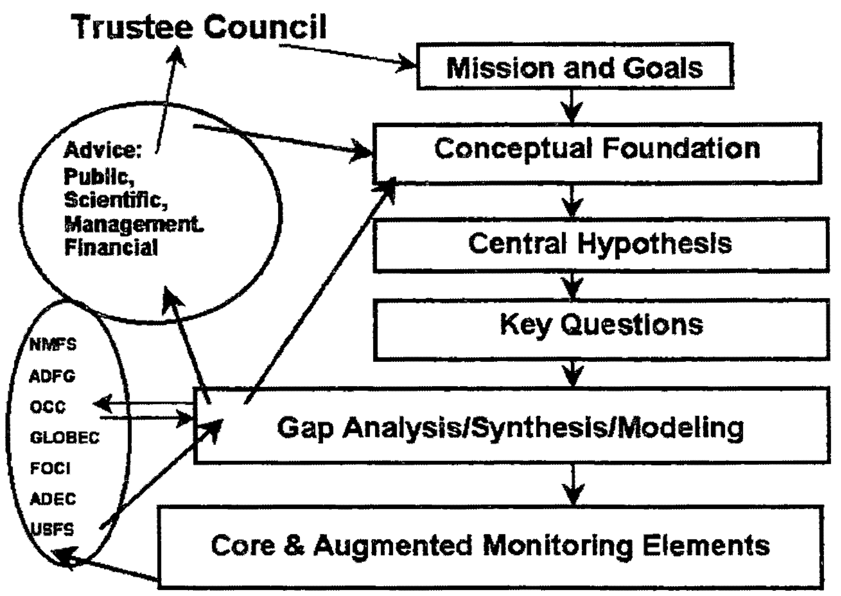


Figure 4.1 Selecting monitoring elements starts with the mission and goals established by the Trustee Council, as expressed in the conceptual foundation, which is regularly updated by new information from a variety of sources.

4.3 Some Leading Hypotheses

In the section that follows, a number of specific hypotheses about how natural forces and human activities control biological productivity are described. These have been advanced in the scientific literature (see Chapter 3, Volume II).

4.3.1 Match-Mismatch Hypothesis

The essence of the match-mismatch hypothesis is as follows:

- Populations of organisms are adapted to certain environmental conditions.
- When those conditions change rapidly, predator and prey populations may not track in the same way.
- As a result, transfer of energy into the higher levels of the food web is compromised.

This hypothesis has been proposed by Mackas to explain changes in production with the slow shift to earlier emergence of *Neocalanus* copepods at Ocean Station P in the last several decades (Mackas et al. 1998). The match-mismatch hypothesis was also invoked by Anderson and Piatt to explain ecological changes observed in a long time series of small-mesh trawl sampling around Kodiak Island and the Alaska Peninsula (Anderson and Piatt 1999).

4.3.2 Pelagic-Benthic Split

Eslinger et al. (2001) suggested that strong inshore blooms of spring phytoplankton that occur in conditions of strong stratification put more biological production into the benthic ecosystem, in contrast to weaker, but more prolonged blooms, that occur in cool and windy growing seasons. Under the latter conditions, it has been proposed that biological production is more efficiently used by the pelagic ecosystem and that relatively less of the production reaches the benthos. It is conceivable that during a series of years in which one condition is much more prevalent than the other, food might be reallocated between pelagic-feeding and benthic-feeding species. Or strong year classes of particular long-lived species might result either from conditions of strong stratification causing more biological production or weaker blooms, leading to dominance of the system by certain suites of species.

4.3.3 Optimum Stability Window Hypothesis

Gargett (1997) proposed that there is a point in the range of water stability below which water is too easily mixed downward, resulting in less than maximum productivity, and above which the water is stratified to the extent that it resists wind mixing. Gargett proposed that the fluctuating differences in salmon production between the California Current and subarctic gyre domains are ultimately the result of these two systems being on different parts of this response curve at different times.

4.3.4 Physiological Performance and Limits Hypothesis

A number of explanations for long-term change more simply propose that the abundance of certain species, mainly fish, is a direct response to their physiological performance in different temperatures. Under this hypothesis, the changes in dominance of cod-like fishes and crustaceans that were seen in eastern Canada around 1990 and in the northern GOA around 1978 were initially a response to warm (ascendancy of gadids) or cold (ascendancy of crustaceans) water temperatures. In other words, the main agents of change are the direct effects of warmer water temperatures acting on physiological functions of individuals, in addition to the combined effects of freshwater input, winds, and temperature on ecological processes.

4.3.5 Food Quality Hypothesis

The food quality hypothesis is also referred to as the junk food hypothesis. It attributes declines of many organisms of higher trophic levels observed in the last several decades (harbor seals, sea lions, and many seabirds) to the predominance of suites of forage species that have low energy content (less lipid) than previous food sources (for example, gadids and flatfishes). Consistent with this hypothesis is evidence from the Trustee Council's APEX program, which showed that it takes about twice as much herring as pollock to raise a kittiwake chick to fledging during the nesting season. With the relative rarity of capelin and sand lance in the diets of seabirds in PWS during the last several decades, it seems that many of the population declines might be at least partially attributable to the role of these fatty fish in seabird diets. The change in food sources has been advanced for marine mammal populations that have been in decline.

4.3.6 Fluctuating Inshore and Offshore Production Regimes Hypothesis

The GEM plan provides the first presentation of the model consisting of fluctuating inshore and offshore production regimes. Although this model is closely related to the Gargett hypothesis of an optimum stability window, it proposes that under the same set of atmospheric forcing conditions opposite production effects are seen inshore and offshore. Figure 4.2 illustrates some features of this model.

FIGURE 4.2 is a series of figures illustrating the components of the J. Allen "Gulf Ecosystem" figure. Bob Spies will identify the figures.

The model was developed as a result of observing during the last several decades that populations of many seabirds, harbor seals, and sea lions, which forage mainly in inshore waters, have been declining while marine survival of salmon and high levels of offshore plankton and nekton suggested that offshore productivity was very high. It is proposed that the various manifestations of climate forcing have combined since about 1978 (positive Pacific Decadal Oscillation [PDO]) to make the ocean more productive offshore. Characteristics of the offshore ocean include more upwelling of deep nutrients and a mixed surface layer that is shallower and more productive. These same climatic conditions are proposed to have made the inshore areas of the GOA less productive. During the positive PDO, greater freshwater supply (precipitation on the ocean and terrestrial runoff) results in greater-than-optimal nearshore stratification. Also, during the positive PDO, greater winds cannot overcome the stratification during the growing season, but do inhibit the relaxation of downwelling. Therefore, fewer nutrients are supplied to the inshore regime from the annual run up of deep water onto the shelf. During a negative PDO, the opposite pattern in biological response results from a colder, less windy, and drier maritime climate.

4.3.7 Incremental Degradation Hypothesis

Marine environments around urbanized areas (such as Los Angeles, Puget Sound, Boston Harbor, San Francisco Bay, and New York Bight) and watershed systems (Columbia River Basin and San Joaquin River) have highly altered ecosystems that contain invasive exotic species, individuals impaired by contamination, and fish populations that have been highly altered by the combined effects of various human alterations. Although much of this degradation took place before policies for a sustainable natural environment were in place, it appears that this degradation occurred through a long period of time and as a result of the combined impacts of many different human activities. To this day, no regional programs track the combined impacts of all human activities.

4.4 Principal Ecological Concepts

Production at the base of the food web, referred to as primary productivity and strongly influenced by physical forces, ultimately determines ecosystem productivity. However, the abundance of any particular population depends on three things: immediate food supply (prey), removals (mortality), and habitat.

All animals and plants in the oceans ultimately rely on energy from the sun or, in some special cases, on chemical energy from within the earth. The amount of solar energy converted to living material determines the level of ecosystem production (total amount of living material and at what rate it is produced). As a rule of thumb, populations of individual species (such as salmon, herring and harbor seals) cannot exceed about 10% of the biomass of their prey populations (about the average conversion of prey to predator biomass). Therefore, the amount of energy that gets incorporated into living material and the processes that deliver this material as food and energy to each species are key factors influencing reproduction, growth and death in species of concern. Increases in prey, with other factors such as habitat being equal, generally allow populations to increase through growth and reproduction of individual members. At the same time, there are factors that lead to decreases in populations–decreases in suitable habitat, decreases in growth and reproduction, and increases in the rate of removal (death) of individuals from the population. As a result, the combined effects of natural forces and human activities that determine food supply (bottom-up forces), habitat (bottom-up and top-down forces), and removals (top-down forces) determine the size of the population of any animals of concern by controlling reproduction, growth, and death.

4.4.1 Physical Forcing and Primary Production

The vast majority of the energy that supports ecosystems in the GOA comes from capture, or fixation, of solar energy in the surface waters. How much of this energy is captured by plants in the ocean's surface layer and watersheds and passed on ultimately determines how much biomass and production occur at all levels in the ecosystem. Capture of solar energy by plants in the oceans and watersheds and the conversion of solar energy to living tissue (primary production) depends on several interacting forces and conditions that vary widely from place to place, season to season, and year to year as well as between decades. Needless to say, without a clear understanding of how these changes occur, it will not be possible to understand the most important aspects of ecological change in the GOA. The process of capturing solar energy is explained below.

First, in the ocean, primary production occurs only in the relatively shallow photic zone in which sunlight penetrates (a few hundred feet). In watersheds, cloud cover and shading play a larger role in variability of productivity. Second, plants that fix this energy, by using it to make simple sugars out of carbon dioxide and water, depend on nutrients which are absorbed by the plants as they grow and reproduce. Solar energy that is not captured by plants in the ocean warms the surface waters, making it less dense than the water beneath the photic zone, which causes layering of the water masses. A continuous supply of nutrients to the surface waters is necessary to maintain plant production. Likewise, terrestrial plants depend on nutrients carried from the ocean by anadromous fish. Because the deep water of the GOA is the main reservoir of nutrients for shallow waters, and apparently also an important source for watersheds, the processes that bring nutrients to the surface and into the watersheds are key to understanding primary, and, therefore, ecosystem productivity. Changes in nutrient supply on time scales of days to decades and space scales from kilometers to hundreds of kilometers have important impacts on primary production, generating perhaps as much as a thousand-fold difference in the amount of solar energy that is captured by the living ecosystem. Nutrient supply from the deep water is influenced by the properties of the shallower water above (mainly because of the decreasing density of the water toward the surface). Nutrient supply is also influenced by physical forces that can overcome the density differences between deep and shallow water–namely, wind acting on the water surface and tidal mixing. For watersheds, nutrient supply apparently depends strongly on biological transport of marine nitrogen by salmon, which die and release their nutrients in freshwater.

As demonstrated in the scientific background in Chapter 3, Volume II, the knowledge of nutrient supply in the GOA, both how it occurs and how it may be changed on multi-year and multi-decadal scales, is very rudimentary. As the energy of the wind and tides mixes surface and deeper water, it not only brings nutrients to the surface layers, but also mixes algae that fix the solar energy down and out of the photic zone, which tends to decrease primary production. Therefore, other factors being equal, continuous high primary production in the spring-summer growing season is a balance between enough wind and tidal mixing to bring new nutrients to the surface, but not so much wind or tidal mixing that would send algal populations to deep water. The seasonal changes in downwelling, solar energy, and water stratification that set up the annual plankton bloom are described in Section 3.6, Volume II, of the scientific background. As noted in that section, however, it is not well understood how differences in physical forces from year to year and decade to decade change primary production many-fold in any particular place.

4.4.2 Food, Habitat, and Removals

Increases in immediate food supply (prey) will translate to population increase, all other factors being equal. The allocation of energy in each individual is key to growth of the population it belongs to. Food supply is converted into population biomass through growth and reproduction of individuals in specific favorable habitats. Therefore, factors in the habitat such as water temperature, distribution of prey, and contaminants that can influence the allocation of food energy to the following activities will influence the population size: chasing and capturing prey, maintaining body temperature (for homeotherms), growth, and reproduction.

Removals are all the processes that result in loss of individuals from the population, or mortality. These processes include death from contamination, human harvest, predation, disease, and competition. For example, harvest of a large proportion of the largest and most fecund fish in a population will soon decrease the population, as will a virulent virus or the appearance of a voracious predator in large numbers.

Also included under the category of removals is any factor that negatively affects growth or reproductive rate of individuals, because such factors can decrease population size. Contaminants are considered potential removals because of the following possible effects:

- Causing damage that makes energy utilization less efficient and requires energy for repairs;

- Interfering with molecular receptors that are part of the regulatory machinery for energy allocation;
- Damaging immune systems that make disease more likely; and
- Outright killing of organisms at high concentrations.

Habitats in marine and freshwater environments are ultimately controlled by temperature and salinity, as modified by many other biological, physical and chemical factors. Basic physiological functions such as respiration and assimilation of nutrients from food occur only within certain boundaries of temperature and salinity. As stated in Section 4.__, a number of hypotheses on the origins of long-term change relate the abundance of certain aquatic species to their physiological performance in different temperatures. For example, changes in dominance of cod-like fishes and crustaceans in eastern Canada around 1990 and in the northern GOA around 1978 were explained as positive responses of gadids to increasingly warm temperatures. Using the same reasoning, the ascendancy of crustaceans such as shrimp in the GOA in the 1950s and 1960s, and in eastern Canada during the 1990s, have been attributed to cooling water temperatures.

On the basis of the first principles of physics, chemistry, and biology, temperature and salinity must be agents of change in biological resources through effects relating to physiological functions in individual plants and animals. Effects on individuals add to the combined effects of freshwater input, winds, and temperature on ecological processes.

4.5 Interactions of Principal Ecological Concepts by Habitat

4.5.1 From Watersheds to the Central Gulf

These ecological concepts can be applied directly to the GOA ecosystem to show how the system and its plant and animal populations are controlled. Total annual primary productivity, natural controls on populations, and human activities change from the edge of the watershed to the central GOA. These changes are related to the physical processes and geographic features depicted in Figure 4.3, a cross section of the GOA from the top of the eastern ringing mountains out past the continental shelf slope. Some key biological features are also depicted in this figure.

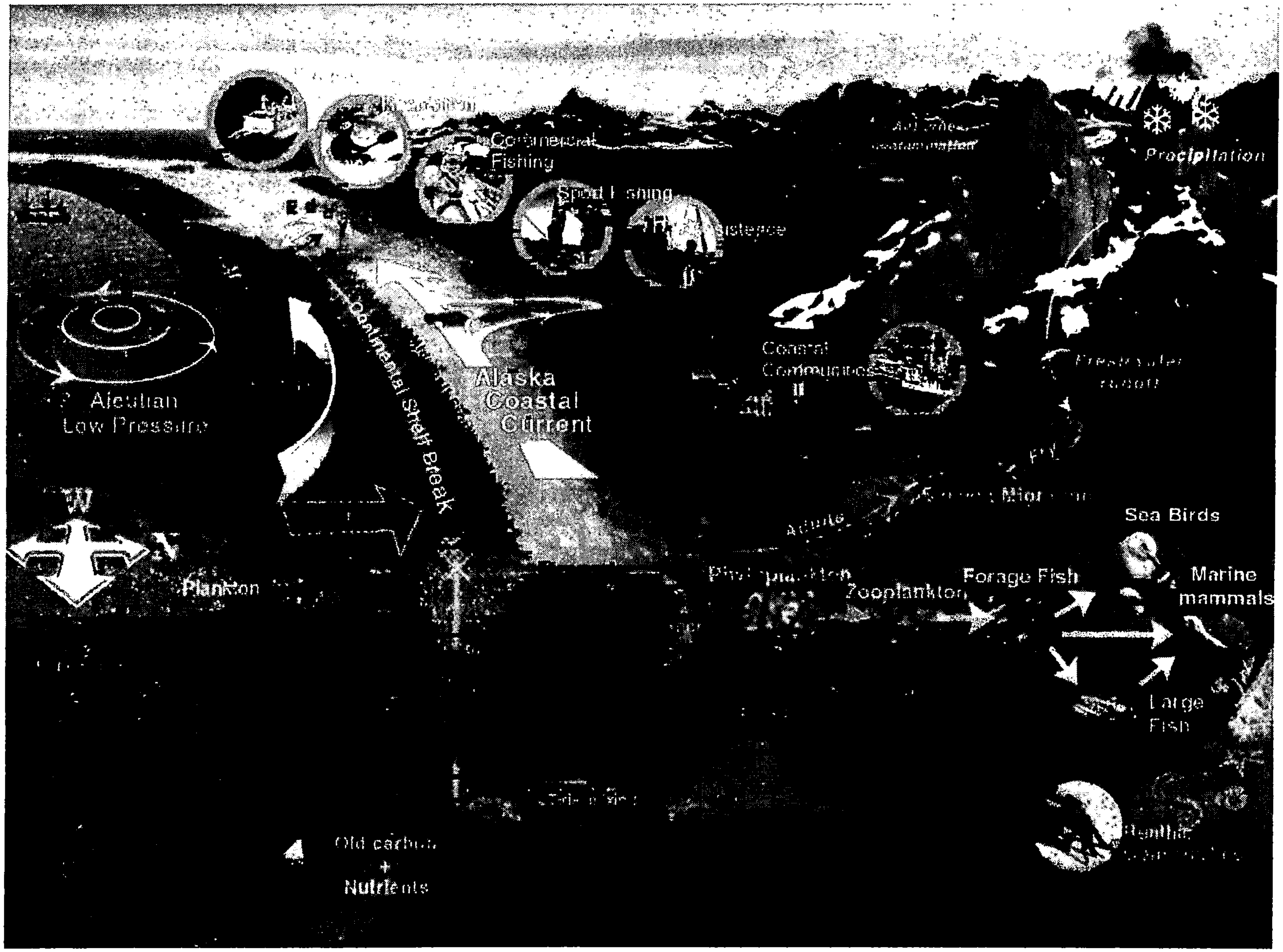


Figure 4.3 Diagram of the northern GOA showing connections among plants and animals, natural forces, and human actions. (J. Allen Alaska Digital Graphics)

4.4.2 Watersheds

Watersheds are linked by geochemical cycles and common climatic forcing to the marine ecosystem. Input of terrestrial carbon contributes to the carbon budget of the oceans. In addition, the incorporation of carbon dioxide by marine plants acts as a pump that potentially sequesters amounts of carbon for long periods of time in the oceans.

4.5.2.1 Physical Forcing and Primary Production

Primary natural forces are precipitation and insolation. Watersheds depend on import of marine nutrients by anadromous fish and other animals. Therefore, maintenance of healthy salmon runs and populations of terrestrial animals that feed in the nearshore marine environment is key to healthy watershed ecosystems. Woody debris and vegetation from land are also imported to the marine environment, providing a carbon source and habitat for some species. The common effects of climate also link these two systems. Fresh water from coastal watersheds contributes huge amounts of fresh water to the GOA and makes possible the ACC–the single most dominant and integrating feature of the physical environment on the continental shelf.

4.5.2.2 Food, Habitat and Removals of Valued Species

Human activities in the watersheds that remove natural vegetation can result in soil erosion and its attendant effects on stream and coastal marine life. Fresh water can carry contaminants to the marine environment. Sources of these contaminants can be of local origin–sewage and septic wastes, industrial and military wastes, motor vehicles, and oil from spills–or imported from distant sources and carried across the Pacific Ocean by atmospheric processes.

4.5.3 Intertidal and Subtidal

The intertidal and subtidal–or nearshore–area is technically a part of the ACC regime in most places, except arguably in some embayments, such as the fjord systems in northern PWS. But, because of the importance and vulnerability of the intertidal and shallow subtidal areas and the dependence of so many valued species on nearshore habitat, it is treated here separately from the ACC.

4.5.3.1 Physical Forcing and Primary Production

The productivity of intertidal and subtidal marine communities depends on both fixed algae and some other vascular plants in shallow water, as well as free-floating phytoplankton. Nutrient supply to fixed plants is not well characterized, but presumably is controlled by oceanographic processes and seasonal cycles of water turnover on the inner shelf as well as some contributions from stream runoff. This process of nutrient supply is essentially the same as for nearshore phytoplankton. Ultimately, as mentioned in Section 3.5, Volume II, the run up of deepwater from the central GOA onto the shelf and some poorly characterized processes for cross-shelf transport of the nutrients are critical to growth of both fixed and floating nearshore algae. The nearshore waters can be depleted of nutrients during the growing season if the warm surface layers where primary productivity is drawing down nutrients is not mixed with deeper waters by wind and tidal action. Within-season variability in primary production, therefore, appears to depend on the previous late summer run up of deepwater onto the shelf, some poorly described cross-shelf transport processes, and within-growing season wind and tidal mixing.

Cloud cover also is likely to be very important in regulating the amount of solar energy reaching the ocean surface. Nearshore turbulence, which is the result of the prevailing climate and tidal action, promotes the growth of algae and phytoplankton. These plants are the food supplies for filter-feeding molluscs, such as clams and mussels, that are important sources of food for a variety of nearshore animals, such as sea otters and sea ducks. Climate also directly affects intertidal and subtidal animals through changes of temperature, water salinity, and ice formation. Ice formation is an important source of mortality and reduced growth of intertidal algae and some animal populations in some situations. It is suspected that bottom-up forcing through variability of primary production is an important influence on intertidal invertebrate communities on the scale of decades, but there are no long-term data sets to examine this supposition. If wave action is too intense, it can limit population growth; for example, waves during storms often throw large amounts of herring eggs (embryos) onto the beach where they die.

In addition to these natural factors, human activities in the intertidal and subtidal area and human accidental releases of toxic materials have the potential to affect nearshore primary production. At the present time, it appears that the influences of natural forces on basin and regional scales in nearshore ecosystem productivity are overwhelming and that human influences are negligible, except in local areas (such as harbor contamination).

4.5.3.2 Food, Habitat and Removals of Valued Species

A large number of intertidal and subtidal animal populations respond to both bottom-up and top-down natural forcing as well as to human activities. Bottom-up forcing appears to have more documented effects on such populations as herring, pollock, shrimp, crab, salmon, and seabirds than have been documented for infaunal and intertidal animals. There are good examples of population controls by removals (top-down influences) and many of these relationships, such as that between sea urchins and otters, are cited in Section 3.7, Volume II. Disease possibly influences some populations, such as *Viral Hemorrhagic Septicemia* virus effects on Pacific herring in PWS.

The intertidal and subtidal benthos is particularly vulnerable to human use through harvesting of various invertebrates, trampling, release of contaminants, road and home construction, and soil erosion. At the present time, impacts of such activities appear to be localized because of the dispersed nature of human activities along the vast coastline of the northern GOA. The nearshore sentinel populations may need to be monitored more closely, however, as Alaska's population and use of the nearshore zone expands in the future.

4.5.4 Alaska Coastal Current

As noted above, the domain of the ACC in many cases starts at the shoreline and extends out to a frontal area several tens of kilometers onto the continental shelf. The inshore boundary of this current system is not precisely defined in this subsection because the nearshore aspects of the ecosystem have been covered above.

4.5.4.1 Physical Forcing and Primary Production

Because the ACC is a buoyant, low-salinity, eastern boundary current fed essentially by a line-source of fresh water along the length of the Alaska coastline, it offers a unique opportunity to study basin-scale physical forcing of biological production. Although one characteristic of the ACC is the draw-down of nutrients during the growing season to levels that are undetectable, the in-season variability, clearly driven by patterns in the aforementioned wind mixing, is very significant. A promising model developed by Eslinger et al. (2001) is capable of tracking the in-season variability of plankton production based on the physical characteristics of the water column and the wind field. The extent to which patterns of seasonal wind mixing are the major contributors to longer-term variability in primary productivity is not clear. Tidal mixing likely contributes to variability, as do other potential mechanisms that transport deep-water nutrients into shallow waters; for example, late-summer relaxation of Ekman transport and up-canyon currents.

Annual variability of nutrient supply likely has a great influence on long-term variability in primary production. For example, this influence would be consistent with the relationship between the Bakun upwelling index and pink salmon marine survival rates up to 1990 (see Section 3.6, Volume II) and the differences observed between the volumes of settled plankton in the 1980s and the 1990s (E. Brown, unpublished).

Another physical phenomenon that apparently affects biological production in the water column is eddies. Eddies have been documented in Shelikof Strait, for example, and greatly influence retention of larval pollock in a favorable environment. Beyond their study in the FOCI program, not much is known generally about eddies in the ACC and their biological influences. There are also eddies in Kachemak Bay, some of which are stratified at the surface by freshwater inputs that may similarly benefit pelagic species there and off Kayak Island southeast of PWS. The southerly and easterly winds that predominate during most of the year drive offshore water inshore (via Ekman transport), carrying offshore planktonic organisms close to shore and providing potential sources of food for nearshore organisms, such as juvenile pink salmon.

Finally, the outer edge of the ACC often forms a front with the water masses seaward of it. This front is characterized by strong convergence of offshore and inshore water masses and significant downward water velocities. It appears at times to concentrate plankton, nekton, fish, and birds, and is probably an important site for trophic interactions.

4.5.4.2 Food, Habitat and Removals of Valued Species

Many of the types of natural and human activities that affect the nearshore species apply also to the ACC. This similarity is due in part to the fact that many species cross between the nearshore environment and deeper waters. Bottom-up forcing appears to be of great importance, because areas of the ACC with high levels of chlorophyll a during the growing season and vigorous vertical mixing, such as Lower Cook Inlet, also support large populations of fish, seabirds and marine mammals. The ACC is the main domain of the GOA for the productive fisheries for both pelagic and benthic species. Consequently, human activities are potentially a quite large aspect of removals. Other possible human impacts include contaminants and long-term global warming.

4.5.5 Offshore: Alaska Current and the Subarctic Gyre

4.5.5.1 Physical Forcing and Primary Production

In the offshore areas of the Alaska Current and the subarctic gyre, forcing by winds associated with the Aleutian Low pressure system have a profound effect on production and shoreward transport of plankton. Production and shoreward transport of plankton are determined by the following:

- Upwelling at the center of the subarctic gyre;
- Depth of the mixed layer (freshwater and solar energy input set up the mixed surface layer where primary production takes place);
- Possible upwelling of nutrients along the continental slope and at the shelf break where the shelf break front may direct upwelled water toward the surface; and
- Formation of eddies along the shelf break that may incubate plankton in a favorable environment for production and be mechanisms of exchange between offshore and shelf water masses. Individual eddies may persist for months and are therefore potentially important in any one growing season.

The contrasts in biological production and shoreward transport of plankton between intense and relaxed Aleutian Low pressure conditions in the Alaska Current region and the subarctic gyre are profound. In periods with more negative atmospheric pressure that is keyed by the northeastern movement of the ALP into the GOA in winter, the following interrelated physical changes are observed:

- Acceleration of the cyclonic motion of the Alaska Current and subarctic gyre;
- Increased upwelling in the middle of the subarctic gyre (and possibly along the continental shelf);
- Entrainment of more of the west wind drift (southerly portion of the subarctic gyre) northward into the GOA, rather than into the California Current system;

- Warmer surface-water temperatures and increased precipitation and fresh water runoff from land;
- Freshening of the surface layer;
- Increased winds and Ekman transport; and
- Increased onshore downwelling.

These phenomena are thought to cause the following biological changes:

- The result of the shallower mixed surface layer is that the spring plankton production is likely higher (remember that nutrients may not be limiting in the subarctic gyre).
- Greater standing crops of zooplankton and nekton that have been observed are probably made possible by the higher productivity of the phytoplankton.
- More food is available for the fish that feed on plankton and nekton, such as salmon.
- Salmon populations track mean atmospheric pressure for the wintertime sea surface on scales of decades.

In addition to the multi-decadal oscillations of atmospheric pressure, climate changes manifested in the northern GOA also include periodic El Niños and the long-term warming of the oceans. El Niños have been associated with successful recruitment of a series of groundfish species, such as pollock, as well as some die-off of seabirds. Because the El Niño phenomenon appears to be manifested solely in warming of the upper 200 m of the ocean, its biological effects are probably mediated through water stratification and its relationship to primary production and growth of larval fish.

4.5.5.2 Food, Habitat and Removals of Valued Species

The Alaska Current is centered over the shelf break, an area of high biological activity. The high concentrations of plankton observed at the shelf break, whether they result from accumulation of plankton originating further offshore, in situ production, or both, provide a rich resource for a variety of organisms and their predators. It is not clear that juvenile salmon feed in this regime, but adults of all species certainly do. Other prominent organisms include sablefish, myctophids (lantern fish), sea lions, some seabirds, and whales. Well-developed benthic communities exist on the outer shelf, shelf break, and continental slope, including commercially exploited populations of shrimp, crab, cod, halibut, and pollock. Some fishing activities, such as bottom trawling, have the potential to do habitat damage and possibly limit populations of animals associated with the sea bottom. Issues associated with the balance between production and removals of commercially important species are of the utmost societal importance in Alaska and further ecological information, modeling, and synthesis centered on the Alaska Current regime is necessary.

4.6 Regional Changes Resulting from Interacting Ecological Factors

In general, regional differences in populations of fishes, birds, and marine mammals in the northern GOA are well known, but the underlying interacting ecological factors that give rise to these differences are not as well understood. In this section, some of the observed regional differences and some potential reasons underlying them are advanced. These explanations of regional differences are based on incomplete or piecemeal evidence, but this speculation is important because it may lead to further study and analysis and to new understanding. Comparative analysis of interacting factors in several regions may better clarify the role of various geographic features, physical forcing, and biological consequences in the northern GOA, as was emphasized in relation to seabirds (Section 3.9, Volume II). Because there is so much homogeneity in the ACC, in particular, what happens in PWS, along the Kenai Peninsula, in outer and middle Cook Inlet, and in the Shelikof Strait may well represent four different field experiments in the same body of water.

One of the most prominent regional contrasts is the different levels of ecosystem productivity apparent in lower Cook Inlet and PWS. It is relatively clear from satellite measurements of surface-water chlorophyll a and the large populations of forage fishes, seabirds, and marine mammals that occur there that the lower Cook Inlet area is extremely productive in the summer growing season relative to PWS. Satellite data for the sea surface temperatures indicate that cold deep water, which is presumably also rich in plant nutrients, is on the surface whenever images are available, and in satellite images taken at the same times, PWS appears to have warmer surface water. The strong mixing that brings deeper water to the surface in this area is probably largely tidal in nature. Vigorous mixing is encouraged by:

- The local geography and oceanography, such as the large tide range;
- The large volume of water that is exchanged with each tidal cycle; and
- The narrow entrances to outer Cook Inlet relative to the area of Cook Inlet.

Another regional difference on a somewhat smaller scale occurs within Cook Inlet itself. In Cook Inlet, studies of forage fish abundance and seabird populations at Gull Island on the eastern side and Chisik Island on the western side provide an interesting contrast that strongly suggests physical forcing on seabird populations. At Gull Island, populations of all major seabirds have been increasing during the last 20 years, and at Chisik Island the opposite trend has occurred. This difference appears to be caused by marine-influenced conditions near Gull Island where the food web probably has much greater access to deep-water nutrient sources. At Chisik Island, however, the system is strongly influenced by nutrient-poor, silty freshwater runoff from the major glacial rivers of northern Cook Inlet, and only meager populations of forage fish exist within the foraging range of most species. It appears that with a warmer climate and more runoff, the dynamic balance between fresher water coming down the western side of Cook Inlet and saltier offshore water entering Stevenson and Kennedy entrances has been shifted to make Chisik Island less productive and Gull Island more productive. Eddies, which have been known to exist for some time near Gull Island in Kachemak Bay, have recently been shown to provide a less-dense surface lens in which forage fish favorable to seabirds reside.

Another example of regional differences in geography and physical forcing shaping important differences in ecological production is the eddy system in Shelikof Strait. As mentioned above, this system has been extensively explored and modeled during the FOCI program. This eddy system retains larval pollock in relatively favorable conditions for growth and allows them to eventually contribute to the important pollock fishery in the northern Gulf.

The Trustee Council's SEA program, hatchery production records, and other studies, such as those carried out on kittiwake reproduction, have demonstrated important subregional ecological differences between northern and southern PWS as well as eastern and western PWS.

The pattern of some differences may have changed on a decadal scale. The following regional differences are apparent in PWS:

- Residence time of water in different portions of PWS, with longer residence time in the northern portions of the sound that have more restricted water circulation;
- Degree of incursion of the ACC into the sound, which appears to vary annually;
- Glacial runoff, which is greater in the north and east; and
- Extent of subtidal habitat, which is greater in the eastern portions of PWS.

4.7 Central Hypothesis and Questions by Habitat Type

4.7.1 Central Hypothesis

> ***Natural forces and human activities working over global to local scales bring about short term and long lasting changes in the biological communities that support birds, fish, shellfish and mammals. Natural forces and human activities bring about change by altering relationships among defining characteristics of habitats and ecosystems such as heat and salt distribution, insolation,***

biological energy flow, freshwater flow, biogeochemical cycles, food web structure, fishery impacts, and pollutant levels.

The central hypothesis states widely held beliefs about what drives changes in living marine-related resources in time and space. Specific mechanisms that cause change are largely untested. However, current speculations, supported by limited observations, are that forcing by winds, precipitation, predation, currents, natural competitors for food and habitat, fisheries, and pollutants change living marine-related resources over different scales of time and space through alteration of critical properties of habitats and ecosystems.

Piatt (figure —)

Having an appreciation for the scales of time and space over which the processes responsible for biological production occur is essential for designing monitoring and research intended to detect and understand changes in the ecosystem. To understand the composition and extent of ecosystems, it is necessary to ask and answer questions about the distances and time associated with the variation in the biological and physical phenomena. As stated eloquently by Ricklefs (1990) (p. 169), "Every phenomenon, regardless of its scale in space and time, includes finer scale processes and patterns and is embedded in a matrix of processes and patterns having larger dimensions." Indeed, spatial and temporal scales are part of the definitions of physical and biological processes such as advection and growth. Taking account of spatial and temporal scales is critical to studying linkages between natural forces biological responses (Francis et al. 1998).

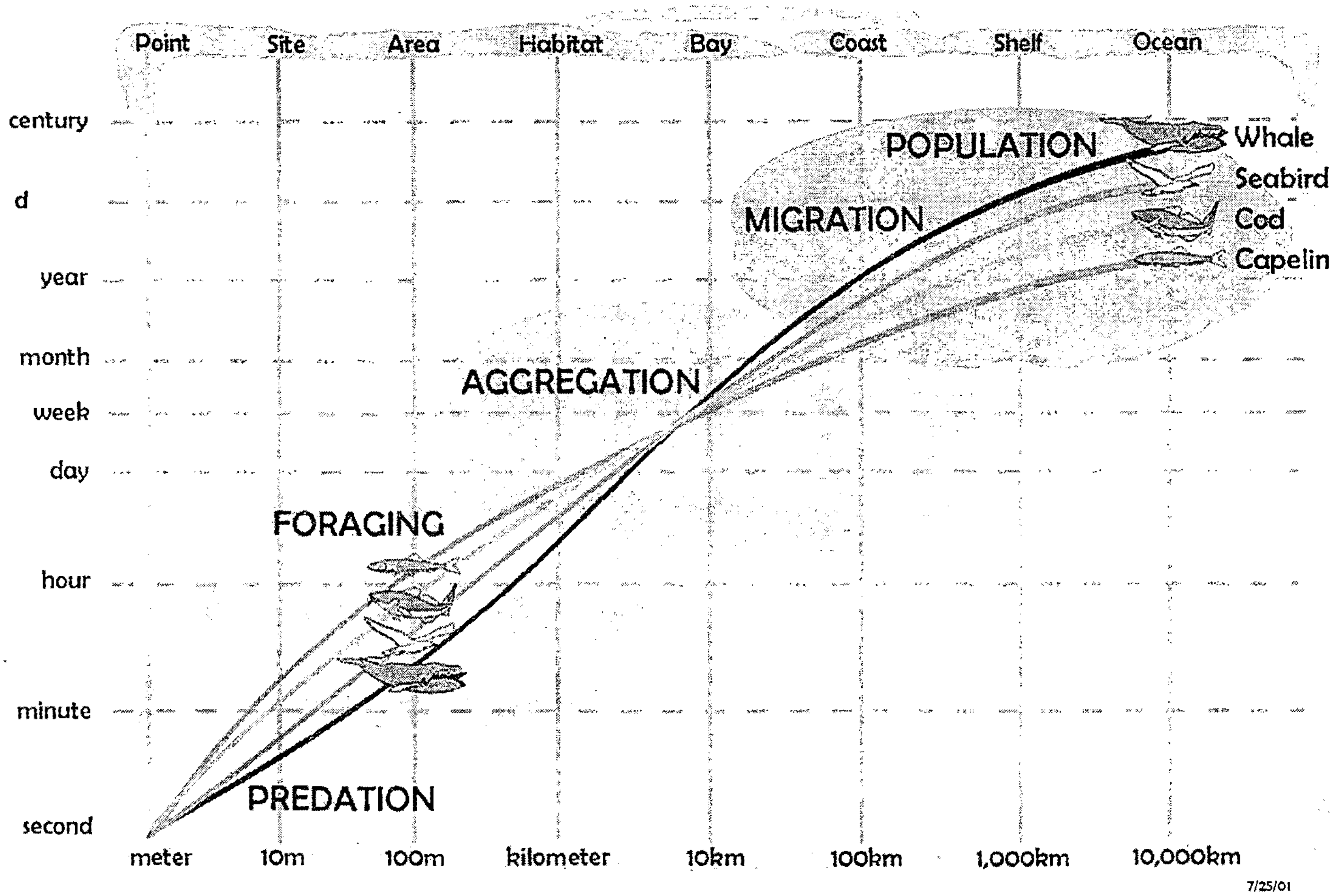
The central hypothesis easily can be converted into a central question designed to explore the means by which natural forces and human activities drive biological responses over different scales of time and space:

What are the relative roles of natural forces and human activities, as distant and local factors, in causing short-term and long-lasting fluctuations changes in the biological communities that support birds, fish, shellfish, and mammals in the four key habitats of the GOA?

The following four habitat types, as formally defined in Chapter 3, Volume I, provide points of reference for studying the relations among species in spatially and ecologically separated habitats. The intent is to implement monitoring that can, in the long term, help understand the relationships between productivity or community structure of a habitat and the other three habitats. Thus, the central question can be specifically targeted to each of the habitats.

Watershed (see Section 3.2, Volume I).

What are the relative roles of natural forces, such as climate, and human activities, such as habitat degradation and fishing, as distant and local factors, in causing short-term and long- lasting changes in marine-related biological production in watersheds?



Piatt figure

Intertidal and Subtidal (see Section 3.3, Volume I).

> ***What are the relative roles of natural forces, such as currents and predation, and human activities, such as sediment and pollutant discharge, as distant and local factors, in causing short-term and long-lasting changes in community structure and dynamics of the intertidal and subtidal habitats?***

Alaska Coastal Current (see Section 3.4, Volume I).

> ***What are the relative roles of natural forces, such as the variability in the strength, structure and dynamics of the ACC, and human activities, such as fishing and pollution, in causing local and distant changes in production of phytoplankton, zooplankton, birds, fish, and mammals?***

Offshore (Outer Continental Shelf and Alaska Gyre) (see Section 3.5, Volume I).

> ***What are the relative roles of natural forces, such as changes in the strength of the Alaska Current and Alaskan Stream, mixed layer depth of the gyre, wind stress and downwelling, and human activities, such as pollution, in determining production of carbon and its shoreward transport?***

4.8 References

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5. MODELING

In This Chapter

- A survey of North Pacific models relevant to GEM
- Goals and purposes of gathering and analyzing data with models
- Use of a hierarchal strategy in decision-making
- Modeling strategies and methods

5.1 Introduction

Modeling and observing systems designed to support modeling efforts have been established in the GOA and North Pacific. As a regional monitoring and research program, GEM seeks to build on the strengths of past and existing programs. In this chapter, modeling strategies of established programs are reviewed to provide a starting point for the modeling component of the GEM program. Identification of core variables used in these existing efforts provides an important contribution to developing the GEM monitoring program described in Volume I.

Following the review of modeling efforts, the background necessary to implement a modeling program for GEM is developed. This background includes presentation of explanations and discussion of the purposes of modeling, a hierarchical framework for organizing different types of models, options available in modeling strategies and methods, and the means of evaluating modeling proposals.

5.2 Survey of Modeling

5.2.1 Modeling Strategies of Established Programs

This subsection provides statements summarizing modeling strategies. The information is extracted from Web sites as noted.

GOOS (Global Ocean Observing System).

> Linking user needs to measurements requires a managed, interactive flow of data and information among three essential subsystems of the IOOS [Integrated Coastal Ocean Observing System]: (1) the observing subsystem (measurement of core variables and the transmission of data), (2) the communications network and data management subsystem (organizing, cataloging, and disseminating data), and (3) the modeling and applications subsystem (translating data into products in response to user

> needs). Thus, the observing system consists of the infrastructure and expertise required for each of these subsystems as well as that needed to insure the continued and routine flow of data and information among them.

From "Toward a National, Cost-Effective Approach to Predicting the Future of our Coastal Environment," a Position Paper of the U.S. GOOS Steering Committee, September 2000, PROLOGUE (http://www-ocean.tamu.edu/GOOS/publications/position.html).

PICES (North Pacific Marine Science Organization)/NEMURO (North Pacific Ecosystem Model for Understanding Regional Oceanography).

> Models serve to extrapolate retrospective and new observations through space and time, assist with the design of observational programs, and test our understanding of the integration and functioning of ecosystem components. Clear differences were identified in the level of advancement of the various disciplinary models. Atmosphere-ocean and physical circulation models are the most advanced, to the extent that existing models are generally useful now for CCCC [climate change and carrying capacity] objectives, at least on the Basin scale. Circulation models in territorial and regional seas are presently more varied in their level of development, and may need some co-ordination from PICES. Lower trophic level models are advancing, and examples of their application coupled with large-scale circulation models are beginning to appear. There is a need for comparisons of specific physiological models, and for grafting of detailed mixed layer models into the general circulation models. With upper trophic level models, there are several well-developed models for specific applications, but workshop participants felt there were as yet no leading models available for general use within the CCCC program. This is an area that needs particular attention and encouragement from PICES.

From http://pices.ios.bc.ca/cccc/cccc/taskteam/modelws96.htm (Perry et al. 1997)

GLOBEC (GLOBal Ocean ECosystems Dynamics).

> The physical models ... can be coupled with a suite of biological, biophysical and ecosystems models. Development of biological models should occur concurrently with development of the physical model. Four types of biological or biophysical models are recommended ... Linking outputs from each of these models will allow the examination of ecosystem level questions regarding

top down or bottom up controls in determining pelagic production in the Bering Sea.

From http://globec.oce.orst.edu/groups/nep/reports/rep16/rep16.bs.model.html).

5.2.2 Core Variables for Modeling

Table 5.1 shows spatial domains, currencies, inputs, and outputs for models.

5.3 Purposes of Modeling

The ultimate goal of both gathering data and developing models is to increase understanding. Pickett et al. (1994) ([Pace 2001] p. 69) define this goal, in the realm of science, as "an objectively determined, empirical match between some set of confirmable, observable phenomena in the natural world and a conceptual construct."

A model—Pickett's "conceptual construct"—is useful if it helps people represent, examine, and use hypothetical relationships. Data—Pickett's "confirmable, observable phenomena in the natural world"—can be analyzed with statistical tools such as the following: Analyses of the variance (ANOVAs), regressions, and classification and regression trees (CARTs):

- Mathematical tools such as Fourier transforms or differential equations; and
- Qualitative models such as engineering "free body" diagrams, network diagrams, or loop models.

Fundamental goals of statistical or mathematical analyses are to develop correlative, and perhaps even causal, relationships and an understanding of patterns and trends. In particular, there is a need to distinguish between random variability, noise, and patterns or trends that can be used to explain and predict.

In other words, the goal of gathering and analyzing data is to improve our conceptual and analytical models of the world, and the goal of developing models is to represent and examine hypothetical relationships that can be tested with data.

Table 5.1. Model Spatial Domains, Currencies, Inputs, and Outputs

Model Name/ Model Region	Model Spatial Domain	Inputs	Outputs/Currency
Single-species stock assessment models that include predation	Across EBS and GOA Pollock distributions	Fisheries data and predator biomass	Pollock population and mortality trends—number at age (and biomass at age)
Bering Sea MSVPA	The modeled region is the EBS shelf and slope north to about 61°N	Fisheries, predator biomass, and food habits data. This model requires estimates of other food abundance supplied by species outside the model.	Age-structured population dynamics for key species—numbers at age
BORMICON for the Eastern Bering Sea	The model is spatially explicit with 7 defined geographic regions that have pollock abundance and size distribution information.	Temperature is included and influences growth and consumption.	Spatial size distribution of pollock
Evaluating Alternative Fishing Strategies	U.S. Exclusive Economic Zone	Gear-specific fishing effort, including bycatch	Biomass of managed fish species
Advection on larval pollock recruitment	Southeast Bering Sea Shelf	OSCURS surface currents (wind-driven).	Index of pollock recruitment
Shelikof Pollock IBM	Western GOA from just southwest of Kodiak Island to the Shumagin Islands, shelf, water column to 100 m	From physical model: Water velocities, wind field, mixed-layer depth, water temperature, and salinity, Pseudocalanus field (from NPZ model)	Individual larval characteristics such as age, size, weight, location, life stage, hatch date, consumption, respiration
GLOBEC NPZ 1-D and 3-D Models	Water column (0-100 m) Coastal GOA from Dixon Entrance to Unimak Pass, 100 m of water column over depths < 2000 m 5-m depth bins x 20 km horizontal grid	Irradiance, MLD Temperature, diffusivity, bottom depths, water velocities (u, v, w)	Diffusivity, ammonium, nitrate, detritus, small and large phytoplankton, dinoflagellates, tintinnids, small coastal copepods, neocalanus, and euphausiids (nitrate and ammonium): mmol/m^3 (all else): mg carbon/m^3
Steller Sea Lion IBM	Should be applicable to any domain surrounding a specific sea lion rookery or haul-out in the Bering Sea, Aleutian Islands, or GOA	The main input will be a 3D field of prey (fish) distribution, derived either from hypothetical scenarios or (later) modeled based on acoustic data	Individual sea lion characteristics such as age, location, life stage, and birth date are recorded. Caloric balance is the main variable followed for each individual.

Table 5.1. Model Spatial Domains, Currencies, Inputs, and Outputs

Model Name/ Model Region	Model Spatial Domain	Inputs	Outputs/Currency
Shelikof NPZ Model, 1-D and 3-D Versions	Water column (0-100 m), GOA from southwest of Kodiak Island to Shumagin Islands. 1-m depth bins for 1-D version; 1 m depth x 20 km for 3-D version	Irradiance, MLD, temperature, bottom depths, water velocities (u, v, w).	Nitrogen, phytoplankton, Neocalanus densities, Pseudocalanus numbers/m-3 for each of the 13 stages (egg, 6 naupliar, 6 copepodite)s
GOA Pollock Stochastic Switch Model	Shelikof Strait, Gulf of Alaska	Number of eggs to seed the model. Base mortality, additive and multiplicative mort. Adjustment parameters for each mort. Factor.	Number of 90-day-old pollock larvae through time
NEMURO	Ocean Station P (50°N 145°W), Bering Sea (57.5°N 175°W), and Station A7 off the east of Hokkaido island, Japan (41.3°N 145.3°W)	15 state variables and parameters, including 2 phytoplankton, 3 zooplankton, and multiple nutrient groups	Ecosystem fluxes are tracked in units of nitrogen and silicon.
Eastern Bering Sea Shelf Model 1 Ecopath	500,000 km^2 in EBS south of 61°N	Biomass, production, consumption, and diet composition for all major species in each ecosystem	Balance between produced and consumed per area biomass (t/km^2). Future work will explore energy (kcal/km^2) and nutrient dynamics.
Eastern Bering Sea Shelf Model 2 Ecopath	500,000 km^2 in eastern Bering Sea south of 61°N		
Western Bering Sea Shelf Ecopath	300,000 km^2 on western Bering Sea shelf		
Gulf of Alaska Shelf Ecopath	NPFMC management areas 610, 620, 630, and part of 640		
Aleutian Islands, Pribilof Islands Ecopath	Not determined		
Prince William Sound Ecopath	Whole Prince William Sound		

Table 5.1. Model Spatial Domains, Currencies, Inputs, and Outputs

Model Name/ Model Region	Model Spatial Domain	Inputs	Outputs/Currency

Source: Table 2 in "North Pacific Models of the Alaska Fisheries Science Center and selected others," compiled by Kerim Aydin. year?

Notes:
BORMICON = Boreal Migration and Consumption Model
EBS = Eastern Bering Sea
GLOBEC = Global Ocean Ecosystem Dynamics
GOA = Gulf of Alaska
km = kilometer
kcal = kilo calorie
m = meter
MLD =
mmol = millimolar
MSVPA = Multispecies Virtual Population Analysis
NEMURO = North Pacific Ecosystem Model for Understanding Regional Oceanography
NPFMC = North Pacific Fisheries Management Council
NPZ = nutrient-phytoplankton-zooplankton
OSCURS = Ocean Surface Current Simulations
t = metric ton?
YD = days of year

need input to correct: km^2 and m^3

One of the most useful applications of even relatively simple statistical and conceptual models is in experimental design that permits investigating the possible roles of various parameters and their interactions, ranking the relative importance of uncertainties that may need to be resolved (Fahrig 1991, Oosterhout 1998), and estimating impacts of sample size and observational error (Botkin et al. 2000, Carpenter et al. 1994, Ludwig 1999, Meir and Fagan 2000). Statistical models assess how the variability in one or more kinds of data relates to variability of others. To answer the "why" and "how" questions, however, mechanistic models can be used to develop and test hypotheses about causes and effects (Gargett et al. 2001). (Mechanistic in this use is intended to describe the philosophy of mechanism, especially explaining phenomena through reference to physical or biological causes.) For monitoring and modeling to be useful for solving problems, they must contribute to improving decision-making (Botkin et al. 2000, Hilborn 1997, Holling 1978, Holling and Clark 1975, Ralls and Taylor 2000).

Toward this end, one goal of the GEM program is to use models predictively to assist managers in solving problems. It is important that expectations be realistic, however. The mechanisms that drive ecological systems, particularly those related to climate and human activities, are not currently well enough understood for predictions about natural systems to be reliably successful. It is not unreasonable to expect that predictive models that managers will be able to use to produce at least short-term reliable forecasts will eventually be developed, but advances in decision-support models will require a long-term commitment to advancing understanding on which those decision-support models will ultimately have to be based.

Prediction is, however, an important goal of a modeling program even in the short run, because science advances with the development and testing of predictive hypotheses. Mechanistic studies are essential to advancing understanding, but carrying out these studies requires defining cause-effect or predictive hypotheses, and then testing those predictions against subsequent data or events with analytical models.

The fundamental goal of the GEM program is to identify and better understand the natural and human forces that cause changes in GEM species. This research goal has a pragmatic purpose that can only be served, in the end, by linking correlative and mechanistic studies with the predictive needs of decision makers. Decision-making, prediction, and understanding are inevitably linked, and maintaining that link can help keep a research program focused on its ultimate objectives, and help it to avoid narrow inquiry and the distractions of small temporary problems (Pace 2001).

An often-overlooked benefit provided by the process of developing a model is that it can, and probably should, facilitate communication among researchers, managers, and the public.

To summarize, in the GEM program, the specific purposes of modeling are as follows:

- Inform, communicate, and provide common problem definition;
- Identify key variables and relationships;
- Set priorities;
- Improve and develop experimental (monitoring) designs; and
- Improve decision-making and risk assessment.

5.4 Hierarchical Framework

It is critical that the GEM program develop a hierarchical modeling strategy to ensure that short-term, smaller-scale decisions about monitoring and modeling studies will be consistent with the conceptual foundation and GEM program goals. Smaller-scope research studies to test particular hypotheses and develop correlative relationships must fit within a larger synthesis framework connecting the more narrowly focused research disciplines. Deductive studies to relate empirical data to synthetic constructs are just as important as inductive studies to elucidate general principles, and it is important that researchers keep straight whether they are investigating the meaning of the data, given the theory, or the validity of the theory, given the data. Neither can be done unless modeling, monitoring, and data management strategies are developed together.

As described in Chapter 4, Volume I, models for the purposes of the GEM program may be verbal, visual, statistical, or numerical. Statistical models are also known as "correlative" and "stochastic," and numerical models are also known as "deterministic" and "mechanistic." Note that "prediction," "analysis," and "simulation" are terms that describe the use of models, and not necessarily their type (see 4, Volume I). The modeling hierarchy of the GEM program will provide links between observations and explanations, development of theory and design of experiments, and advancement of science and the practice of management. The "top" of this hierarchy, the conceptual foundation, is the source of questions and hypotheses to be explored. Statistical, analytical, and simulation models will be developed explicitly to link the "confirmable, observable phenomena in the natural world" to the "conceptual construct," as Pickett put it (Pace 2001, p. 69).

For example, a visual model of the conceptual foundation is shown in an influence diagram in Figure 5.1, which shows the forces of change on the left and the objects of ultimate interest that are subject to change on the right. In between the two are the intervening elements and relationships on which the human and natural forces act. It is the nature of the connections among these physical and ecological elements that is hypothesized to bring about the changes that the GEM program seeks to understand. Therefore, these connections should provide the overall modeling structure.

"The marine ecosystem in the northern Gulf of Alaska (GOA) depends on the nature of connections between heat and salt distribution, insolation, biological energy flow, biogeochemical cycling and food web structure. Natural changes and human activities bring about changes in the populations of birds, fish, shellfish and mammals by altering these connections" (p. 2).

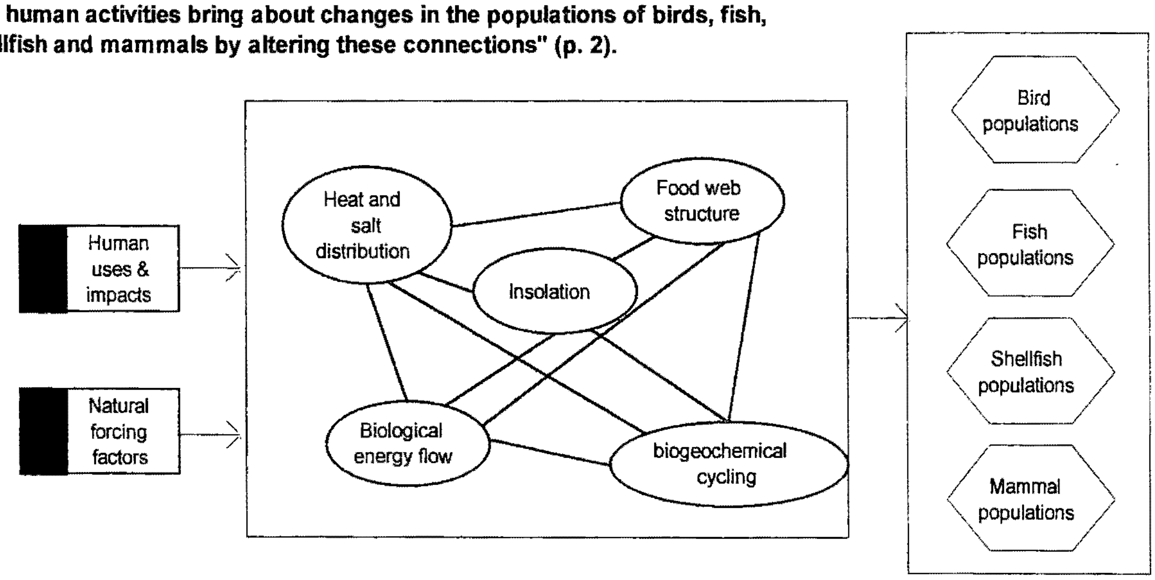

Figure 5.1 Influence diagram illustrating GEM draft conceptual foundation. This figure may be moved to conceptual foundation chapter.

This conceptual model is linked to the monitoring plan through the variables defined as "essential to monitor" in the conceptual foundation, illustrated in a network diagram in Figure 5.2. The analytical relationships between the monitored variables of Figure 5.2 and the conceptual foundation represented by Figure 5.1, are developed and investigated with statistical and analytical tools, called models.

The ultimate goal of GLOBEC's Northeast Pacific modeling appears to be a suite of computer models that represents an entire conceptual foundation. The way this is framed in programs like GLOBEC, the North Pacific Marine Science Organization (called PICES), and Global Ocean Observing System (GOOS) (see Section 5.2 of this chapter) is as linked physical and biological models representing the physical and biological worlds over time and space (marine as well as terrestrial). The NRC describes this idealized goal as follows (p. 16):

> Develop a whole-ecosystem fishery model as a guide to think about what needs to be monitored. Such a model would use current and historical data to relate yields to climate data and contaminant levels and might stress biological and physical endpoints (zooplankton/phytoplankton blooms, macrofauna populations) and climate and physical oceanography endpoints, in conjunction with modeling.

Such a conceptual framework can stimulate heated arguments, creative debate, and perhaps synthesis among researchers who have tended to work in somewhat independent fields with different theoretical foundations and languages (Zacharias and Roff 2000). On a pragmatic level, however, it is too general to help decision makers choose to fund one proposal over another.

A feasible way to proceed from what can be done now is through an iterative process framed by the conceptual foundation (Figure 5.3). The conceptual foundation should be the explicit source of hypothetical correlative and cause-and-effect relationships. Those relationships should be stated as hypotheses, and should be used to determine what needs to be measured and when, where, and how. If the monitoring and modeling plans are developed within this framework, the measurements can be compared to model predictions, the results can be used to update the scientific background and the monitoring plan, and the iteration can continue. This evolutionary process or adaptive feedback loop is illustrated in Figure 5.3.

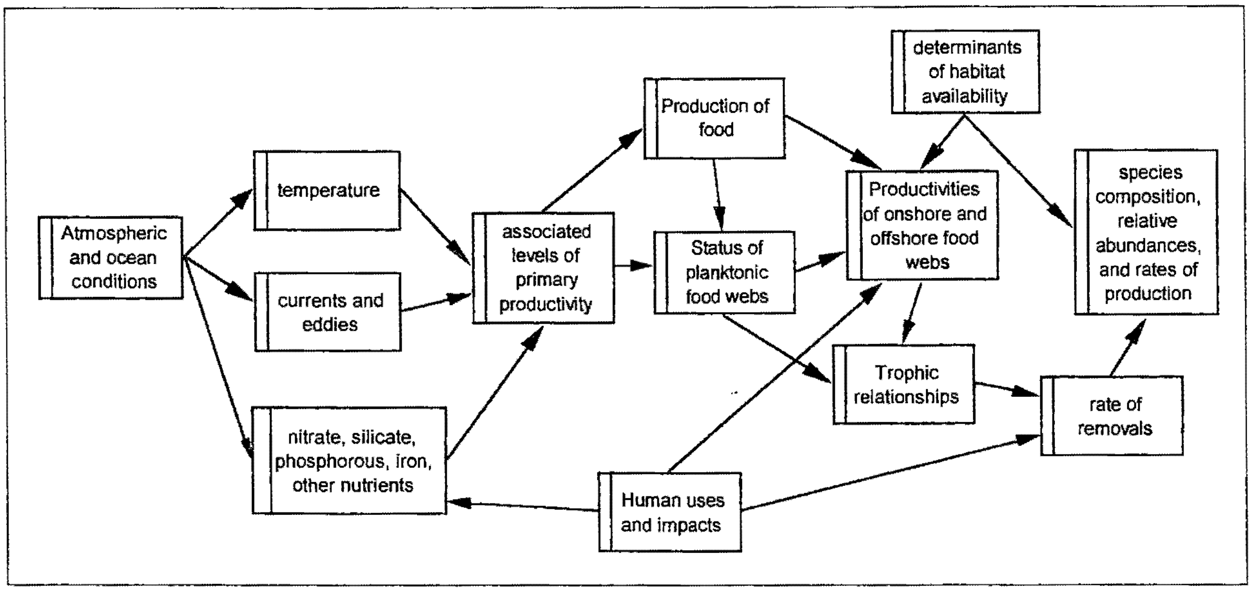

Figure 5.2. Linkages among system attributes that the conceptual foundation identified as "essential" to monitor. This figure may be moved to conceptual foundation chapter.

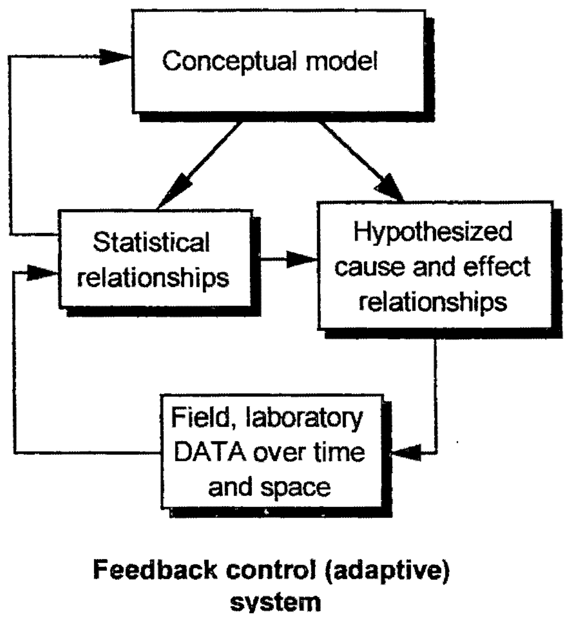

Figure 5.3 Feedback control system linking the conceptual foundation, monitoring, and modeling efforts

5.5 Defining and Evaluating Modeling Strategies

Modeling efforts of the GEM program for the short term will be developed as part of a long-term strategy defined by goals of the GEM program.

To begin with, the modeling strategy must be consistent with GEM programmatic goals (Chapter 1, Volume I). They can be summarized to indicate that GEM modeling should accomplish the following:

- Focus on filling gaps, thus avoiding duplication of efforts or "reinventing the wheel;"
- Emphasize synthesis;
- Depend as much as possible on already existing programs;
- Maintain focus on the key questions; and
- Emphasize efficiency.

In developing a specific management strategy, it is often useful to think of it as a decision framework (Keeney 1992), and to start by defining an ideal. For example, to satisfy GEM program goals efficiently, an ideal model would arguably require input data that are relatively easy to measure, readily available, and reliable indicators of change. The cause-effect theory that drives the modeled system or species behavior would be based not only on statistically valid correlative studies, but also on plausible and well-developed mechanistic studies and their resulting theoretical constructs. The model would produce credible predictions under plausible scenarios, and would help answer questions and raise new ones.

This ideal model would be easy for other scientists and managers to comprehend, and it would be readily available for others to deconstruct, test, and critique. The overarching conceptual model would be modularized so that components of it could be developed and tested relatively quickly by experts from multiple disciplines. Ideally, data already available could be used to test and validate the components and their interactions, and could allow quick learning that could be used to redirect the modeling and monitoring strategies. Sensitivity analysis of the components, and the interactions between the components, would be a highly productive source for subsequent model and monitoring plan development. Model structure would be flexible and have robust mechanisms for assimilating new data and revising model structure. As a result, short-term progress toward the long-term goals could be achieved and documented.

A modeling strategy is the roadmap that provides the means for achieving the ultimate modeling goals. An idealized model like the one described above is a useful step toward defining the attributes of an efficient, workable strategy. Development of such an idealized model can produce a useful communication tool. Table 5.2 identifies preliminary objectives and attributes derived from this idealized model that could be used to evaluate modeling strategies.

Table 5.2 Potential Objectives and Attributes for Use in Evaluation of Modeling Strategies

Objective or Attribute	Supported by models that help...
Relevance to key questions and hypotheses of the GEM program	Identify key variables and relationships Characterize uncertainty and noise, impacts of process and observation error Elucidate general principles rather than narrow, unique focus driven by short-term perceived crisis
Contribution to future model development	Inform, communicate, develop common problem definitions Set priorities, clarify relative impacts of variables and relationships Improve and develop experimental (monitoring) designs Prioritize and elucidate impacts of uncertainties in data and in model structure and assumptions Increase utility of using simpler models to identify key variables and relationships to use in future models Advance the state of the art; for example, increase available methodologies by borrowing from other fields, particularly engineering and medicine, tools such as neural nets, genetic algorithms, CARTs, other kinds of regression (Jackson et al. 2001)
Efficiency of approach	Synthesize, exploit, and integrate existing data and existing programs whenever possible; for example, from oceanographic programs such as NOAA, OCSEAP, GLOBEC, and GOOS Identify and exploit uniqueness of GEM program opportunity; for example, no one else is doing it because it requires a very long time frame Elucidate links between things that are easy to measure and key indicators of change, whatever they might be Elucidate links between correlations (which are usually easier to develop) and explanatory mechanisms (which are usually more difficult)
Maintenance and development of program support	Accessibility of models to end users, other modelers Contribution to data management, data assimilation effort Contribution to solving problems for resource managers and regulators

5.6 Modeling Methods

The modeling "niche" of the GEM program will be defined in part by a gap analysis, particularly focused on where it fits with established major regional programs, especially those of GLOBEC, GOOS, and PICES. A very brief summary of the modeling approaches for these programs is provided in Section 5.2 of this chapter.

The relationship between monitoring, models, and decision-making described here is consistent with the relationships of these programs. The purpose of this section is not to define all the other modeling efforts that might be related to the GEM program. A useful context is provided by a table compiled for GLOBEC by Aydin of NOAA (Seattle), which summarizes North Pacific models of the Alaska

Fisheries Science Center and others (see Section 5.2, Table 5.1, and North Pacific models in Appendix B). Correctly defining the GEM program niche is important to avoid duplication of effort and to make best use of work already being done by others.

Developing a model should be perfectly analogous to designing a controlled experiment. A useful model structure will be driven by the questions it needs to help people answer, not by the computer technology and programming expertise of model developers (although technology and expertise may impose constraints). As a general rule, useful models do not tend to be complex, in part because they must be comprehensible to be believed and used by decision makers. That said, models based on laws of physics, which can be validated against those laws and either data or scale physical models, have advanced farther than ecological models in their ability to provide useful output from highly complex models.

5.6.1 Linkages Among Models and Among Modelers

One of the most important challenges confronting GEM modelers will be to develop common languages and modeling frameworks that will allow them to resolve the temporal, mathematical, ecological, physical, and spatial sources of disconnects among the various academic paradigms. This challenge will require significant commitment to improving communication skills, developing qualitative verbal or visual models, and using intuitive problem-structuring tools that combine different modeling techniques, such as network, systems, or loop models. An additional benefit of this kind of approach is that these types of visual, qualitative models should be comprehensible to researchers from any scientific discipline, managers, and the public. The attribute of being widely comprehensible will help facilitate the support of stakeholders.

The feasibility of managing GEM as a realization of the conceptual foundation will depend in large part on the communication skills of experts in the components and linkages that make up the conceptual foundation. Establishing effective communication among experts from different organizations is a widespread problem facing systems modelers (Caddy 1995), and the GEM program may be in a good position to help advance the cause by making it possible for diverse experts to work together. Experts in these fields should bring substantial background capabilities to their work from their common language of mathematics and science learned in graduate school. The modelers of the GEM program also should be required to demonstrate the ability to work with counterparts to develop a shared systems view and conceptual models.

5.6.2 Deterministic Versus Stochastic Models

Detecting and understanding change requires that uncertainty and variability play a central role in the analyses (Ralls and Taylor 2000).

Two key questions that must be addressed by anyone trying to detect and understand change are the problems of Type I and Type II error. Type I error is "seeing" something that is not really there; and Type II error is concluding something is not there, when it really is. Dealing with these types of error in decision-making requires weighing the evidence that suspected change is caused by a (theoretically) definable pattern or trend or is "normal" process error, observation error; or some combination. Equally important, and often overlooked, is how real indicators of change may be hidden by process or observation error or by incorrect assumptions about how things work.

Dealing with uncertainty and variability in models requires at a minimum carrying out sensitivity analysis on simple deterministic models, with particular emphasis on model structure (Hilborn and Mangel 1997). But it is often more efficient and more useful to incorporate stochasticity into simple models. Stochastic models need not necessarily be more data intensive than deterministic models. Overlooking the assumptions required in choosing a mean (or median) or geometric mean, as a representative value for a deterministic parameter is one of the most widespread, but overlooked, sources of modeling error (Vose 2000). At least stochastic modeling requires that probability distributions be explicitly defined.

Simplistic deterministic models can be every bit as misleading and improper as stochastic models (Schnute and Richards 2001), but because they are more familiar, and their single-number inputs and outputs are easier to think about than uncertainties and ranges, they may lead to false confidence on the part of decision makers. Risk assessment in most fields requires analyzing probability distributions and uncertainties, not mean trajectories (Burgman et al. 1993, Glickman and Gough 1990, Vose 2000).

One fundamental issue of interest to decision makers is often how best to prioritize research efforts. A key part of such an issue is ranking the relative impacts of uncertainties on a decision. In this case, it is possible that thoughtful sensitivity analysis carried out on a simple, deterministic model (or multiple models) may be adequate for the job, particularly as a first step in "weeding out" variables that are likely to be extraneous. But developing a stochastic version of relatively simple models may be more efficient (Vose 2000). If care is taken to distinguish between environmental or process variation and observational or functional uncertainty, then statistical tools such as analysis of variance or regression can be used to investigate the relative impacts of uncertainties (Fahrig 1991, Law and Kelton 1991, Meyer et al. 1986, Mode and Jacobson 1987a, Mode 1987b, Oosterhout 1998, Oosterhout 1996, Ruckelshaus et al. 1997, Vose 2000). This approach can be very helpful in developing analytical structures as well as modeling plans. It also lends itself well to decision analysis and risk assessment because it is similar to the "value of imperfect information" analyses widely used in risk assessment and decision analysis (Hilborn 1997, Keeney 1992, Punt and Hilborn 1997, von Winterfeldt and Edwards 1986).

5.6.3 Correlative Versus Mechanistic Models

The use of statistics-based tools such as regressions to make deterministic or probabilistic predictions will generally be easier than developing deterministic or stochastic biological models, because of a dearth of predictive "laws" of biology, let alone ecology. Because statistics-based models are correlative, cause-and-effect explanations will eventually be needed if change is to be understood and predicted reliably. Because some things are easier and more reliable to measure than others, simple models that can help develop correlative relationships between hard-to-measure parameters and easy-to-measure parameters may be of particular interest.

5.6.4 Modeling and Monitoring Interaction

Models should be developed to use and synthesize readily available data whenever possible. This approach will also help identify data needs. Similarly, whenever possible, monitoring plans should be developed to fit the models that will be used to analyze and interpret them. Data management, assimilation, and synthesis should be key considerations for both monitoring and modeling.

One useful way to incorporate data into improving an existing statistical or simulation model is with the Bayesian revision methods (Punt and Hilborn 1997, Hilborn 1997, Marmorek et al. 1996). Bayesian methods might be useful to consider with respect to the question about how much emphasis should be put on annual forecasts, because Bayesian methods lend themselves well to incorporating incoming data into previous forecasts. This entire approach also lends itself well to decision-analysis techniques.

The GEM program shares the share the view of models as tools for assimilating data and optimizing data collection as expressed for the GOOS program (Intergovernmental Oceanographic Commission 2000, p. 36):

> A validated assimilation model can be most useful in optimizing the design of the observing subsystem upon which it depends. This underscores the mutual dependence of observing and modeling the ocean, i.e., observations should not be conducted independently of modeling and vice versa. For example the so-called "adjoint method" of assimilation can be used to gauge the sensitivity of model controls (e.g., open boundary and initial conditions, mixing parameters) to the addition or deletion of observations at arbitrary locations within the model domain. In this regard, Observation System Simulation Experiments (OSSEs) are becoming increasingly popular in oceanography as way of assessing various sampling strategies. The model is first run with realistic forcing and model parameters. The output is then subsampled at times and locations at which the observations were sampled. These simulated observations are then assimilated into the model and the inferred field compared against the original field from which the "observations" were taken. This allows the efficacy

of the assimilation scheme and sampling strategy to be evaluated (at least to the extent that the model is believed to be a reasonable representation of reality).

5.7 Evaluating Model Proposals

Model proposals should, of course, be evaluated within a decision-structured framework such as that outlined above and detailed in Table 5.2. Proposals must also demonstrate a high probability of actually producing what they propose to produce–meeting the objectives of the GEM modeling strategy. A set of guidelines for evaluating model proposals will be developed for the GEM program in conjunction with development of the modeling objectives. As a starting point, successful proposals will provide the following:

- Define who will use the model and for what. If the proposal is to continue or expand an existing model, it should describe who is currently using it and for what. If relevant, the proposal should also identify who could be using it, for what, and why they are not able to use it now.
- Define the questions the model is supposed to answer, and directly link those questions to the key questions and hypotheses of the GEM program.
- Argue convincingly that the model structure is adequate for the purpose, and that there is not a better (cheaper, faster, more comprehensible, more direct) way to answer these questions.
- Show some kind of schematic (flowchart) that is clear, complete, and concise.
- Explain how uncertainty and variability will be represented and analyzed.
- Describe the system characteristics that will be left out or simplified and how the analysis will evaluate the impacts.
- Define data needs and show how the modeling effort will be coordinated with data assimilation and data management efforts.
- Define validation approach.
- Define how the modeling efforts will be communicated to other scientists, managers, and the public; and how input from model stakeholders will be incorporated into the effort, if appropriate.

5.8 Conclusion

Feasibility and pragmatism in a new program like the GEM program dictate that walking will have to come before running and that focused, simpler models will have to come before large-scale, multi-disciplinary models. Walking first means developing verbal and statistical models where numerical models cannot be developed because of a lack of data and understanding. Learning to run requires developing coupled numerical biophysical models that accurately portray the ecosystem. Running means using the biophysical models in a predictive sense. The models must adapt to changes in the conceptual foundation (Chapter 4, Volume II), because the conceptual foundation is designed to change as new information is incorporated. Nonetheless, no matter how many improvements are made, it is probably not reasonable to expect consensus on how that conceptual foundation should be used to develop a strategic modeling policy.

In a constrained world, "consensus" in practice usually means accepting a strategy that enough decision makers find no more offensive than they can accept; optimization, on the other hand, means figuring out the tradeoffs necessary to achieve as many of the desired objectives as reasonably possible. Adopting a decision-structured approach for the modeling strategy will help ensure that it is driven by the fundamental objectives of the GEM program, that the modeling questions are defined by the conceptual foundation, and the tradeoffs can be defined, weighed, and justified.

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6. DATA MANAGEMENT AND INFORMATION TRANSFER

In This Chapter

- The role of data management
- The kinds of data to be used in GEM
- A description of GEM users and administrative support

Editorial note: References GOOS document, a NASA document, and several Web sites. The Web sites are included inline but may need to be moved to a bibliography.

6.1 The Role of Data Management

The data management and information transfer component of GEM includes the following functions: data receipt, quality control (QC), storage and maintenance, archiving and retrieval, and the systems necessary to automate as much of these procedures as possible. This component also includes programs needed to create the custom data and information products that will be provided to the modeling and applications components, and to the users of this information. Therefore, the data management system for GEM fits well into the definition established by C-GOOS (GOOS 2000).

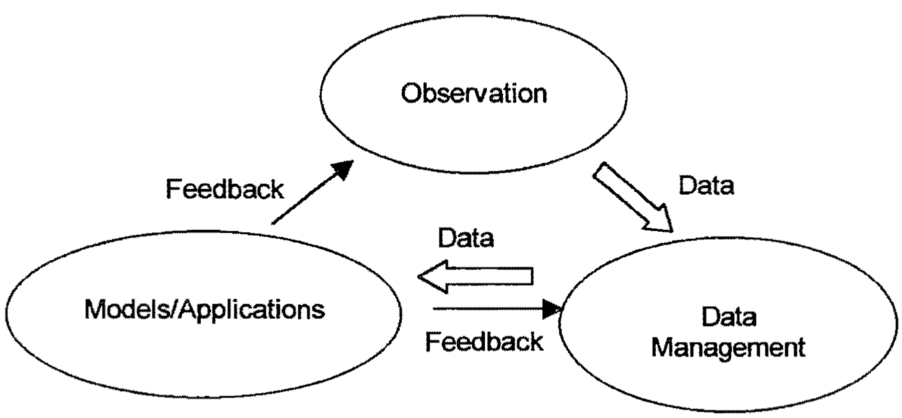

Figure 6.1 GOOS model of data management

The GOOS model is a general description of an end-to-end system that is based on the tripod of observation, data management, and models and applications, with the data management component acting as the intermediary between the observational component and the applications. Data flows from observation through the management system to the modeling and applications component. In turn, the applications component informs and refines both the design of the observational component and the design of the data management system. The monitoring plan may be altered to include new data, regions, or both that are identified during the modeling phase as key to understanding the natural system. The interfaces and data products distributed by the data management system will also be refined with feedback from the applications.

Scientific data management systems have grown rapidly since the advent of the World Wide Web. Initially, projects or groups that collected or archived data made those available over the Web through simple interfaces based on the navigation of links. These supply-oriented systems reflect the structure of the data that was made available by providing links to lists of data sets by years, data set name, or variable name. Many of these systems are still in wide use, although newer systems include more sophisticated search options such as spatial and temporal selection. However, these systems make few assumptions about the intended user community, and it becomes the users' responsibility to locate, evaluate, integrate, and pre-process the data into a form that is suitable for the target application.

As the applications that use scientific data become more sophisticated, and the community is able to access and integrate large amounts of data to address a single problem, new data systems that address the data needs of specific user applications will be built. The output of these systems will be higher-order products such as maps, graphs, visualizations, and data in interoperable formats. NASA has funded some projects with a demand-oriented focus (ESIP NRA), and in the future, more user communities will find ways to build these types of targeted systems.

The landscape of data product delivery will likely include large archives that supply data in a raw or partially pre-processed form. Application-oriented sites will access data from these archive sites through a high bandwidth connection and may use intermediate sites, which provide value-added services that are not available from the originating archive. Common data services available at the archive or through intermediate sites will include subsetting, reformatting, reprojection, regridding, and aggregation.

Although predicting the evolution and the impact of the Web on scientific data delivery is speculative at best, the landscape of future data systems needs to be evaluated to understand the role of the data management component during the extended lifespan of GEM. Initially, GEM will act as both a data archive and a user-focused delivery system, accepting and archiving data from the observational component and creating products that are customized to meet the needs of the habitat-specific applications. During this phase, GEM will establish the procedures for assuring the quality of the data that are submitted to the archive as well as the operational details of ingesting data and making it available. As the archive grows, older data sets will be moved to an archive such as the National Ocean Data Center (NODC) for permanent storage. The GEM program will continue to maintain a meta-database that provides a data search interface to locate and access GEM data that is maintained by the originating project, the GEM archive, or the data archive at NODC.

In the long term, however, the GEM program will likely turn over the entire archiving task to a center such as NODC that is better equipped to maintain the data for extended periods of time. This transition is only possible after the data flow between the observational component and the applications component has been established and the tools and structures are in place to build the custom data products from a distributed set of data archives. The GEM program will retain the meta-database and continue to provide custom data products and services to a set of targeted users.

6.2 Characterizing the Data within GEM

Within the data management component, data is classified by the operations that must be applied to it during the archive and retrieval cycle. This classification often cuts across the content-based classifications used during data analysis. Although biologic data is more often collected by observation or laboratory work and physical data is frequently measured by instrument, there are significant exceptions. A satellite image of ocean color that contains biologic variables will have more in common, in a data management context, with the physical variables in a Synthetic Aperture Radar image than to the phytoplankton results collected from the settled volume of a bottle sample. The settled volume could include both physical and biologic results, but be retained by the data management system as a single data holding. The meta-data and processing that are associated with the chemical and biologic data from the bottle sample will be nearly identical, as will the processing and meta-data associated with both types of satellite imagery.

GEM will be collecting and processing a wide range of data from different collection and recording techniques that present different quality control and assurance challenges. To classify these differences for the data management component, data can be separated into broad categories that reflect the handling and storage requirements. These data categories include:

- **Observational** data collected or recorded by an individual;
- **Measured** data collected by an instrument and stored in formatted files;
- **Modeled** data generated by a running computer model;
- **Geographic** or reference data used by a Geographic Information System; and

- **Remotely sensed** image data taken from a satellite or aerial platform.

The following criteria are used to characterize these data types:

- **Interoperability:** how easily the data can be used in alternate applications;
- **Consistency:** the degree of similarity between the data for different points;
- **Size of file:** the size of the data for a single instance;
- **Number of files:** the number of instances that make up the data set
- **Repeatability:** whether or not the same data can be re-sampled;
- **Lag time:** the length of time needed between collection and submission;
- **Alternative sources:** whether the data is maintained at multiple sites; and
- **Meta-data:** The content, format, or both of the meta-data

6.2.1 Observational Data

Observational data are collected by human observation, laboratory results, and manual data entry. These data include species counts and locations and can include a large number of ad hoc observations of conditions or unrelated sightings. These data are manually entered and capture a person's observations or calculations, which makes them less consistent, often complex, generally low volume, and occasionally error prone. The observations are not repeatable and the formats are not customarily interoperable. The lag time between collection and submission can be long if extensive lab or manual work is involved. The meta-data describe the collection and or processing location and sometimes the conditions. These data are often in a database management system (DBMS) or a spreadsheet, which forces a level of consistency that allows automated processing upon retrieval. Examples of observational data sets from the GEM habitat themes (see Chapter 5, Volume I) include:

Wetlands

- Lab results for stream chemistry
- Plant and animal observations from field study
- Isotopes of nitrogen and levels of phosphorus, silicon, and iron from a lab

Intertidal and Subtidal

- Species counts for substrate classification
- Lab results for chemical and biological oceanography

Alaska Coastal Current

- Lab results for chemical and biological oceanography

- Species counts for zooplankton
- Diet composition for nekton
- Nekton measurements from net tows
- Bird surveys

OCS/Alaska Gyre

- Lab results for chemical and biological oceanography
- Species counts for zooplankton
- Bird and mammal surveys

6.2.2 Measured Data

These data are mostly measurements of physical variables such as air temperature or salinity, but they may also include biologic variables as in the case of the acoustic measurements of the biomass of nekton or zooplankton. These data are usually stored in files with formats that are set by the collection instrument. The data files are consistent across the data set, but have a low level of interoperability with other systems. Because data collection is automated, the size of the files and the number of the files can be large. Usually, little special processing is involved; therefore, the lag time between collection and submission does not need to be long. The meta-data include instrument details and conditions, and the data formats are standard enough to allow customized processing during retrieval. Examples from the GEM habitat themes include:

Intertidal and Subtidal

- Physical oceanographic variables

Alaska Coastal Current

- Lidar measurements
- Hydroacoustic plankton or nekton surveys
- Fluorescence measurements

OCS/Alaska Gyre

- Physical oceanography
- Hydro-acoustic plankton or nekton surveys
- Fluorescence measurements

6.2.3 Modeled Data

Numeric models, and to some degree statistical models, can generate a significant amount of data. As an example, the circulation model can provide a snapshot of ocean current vectors across the GEM region, at many depths, for time steps as small as 10 minutes. Other models produce smaller result sets, but often these results are used by other models as input and must be cataloged and delivered by the data management component. However, unlike most other data sets, these data can be recreated and often are as the model matures. These data are consistent across the data set, can represent a high volume of data, and are not generally interoperable. The lag time between data generation and data submission (and even use) can be very short. The meta-data need to describe the classification and version of the model and may need to include relevant input parameters. The meta-data may be used to track the lineage of the output data, including the references to the input data and, if relevant, the models that created those input data. The modeled output data for GEM is not yet defined.

6.2.4 Geographic Data

These data are the reference data used by Geographic Information Systems (GISs) and include base layers such as elevation (bathymetry) and shorelines, but can also include soil types or habitat characterization. These data formats are rarely used to store data collected by a project, but are frequently used to display the information in the spatial context of a map. These data are usually interoperable across different systems and may be stored at several different locations. The meta-data are focused on the spatial definition and may include information about the resolution or precision of the data. GEM will not generally be ingesting these data from projects, but the program may store reference information in this format, which is also a prime format for custom data products created by the data management component.

6.2.5 Remotely Sensed Data

Remotely sensed imagery can come from satellite or aerial platforms. These are generally large files and may be used on a regular basis by the analysis being conducted by GEM. However, images from NASA or NOAA may not need to be archived if they can be retrieved again from the source. Aerial photography has also been used by EVOS projects to capture the spatial distribution of nekton in PWS. These images, along with satellite images, may in some cases be archived by the GEM program and provided to the application component. These data will require a large amount of storage and are quite interoperable with GIS and image-analysis tools. The meta-data describe the instrument and platform and often include details of the image quality and the spatial reference system. Examples in the GEM habitat themes could include:

Wetlands

- LandSat images of watersheds
- Moderate Resolution Imaging Spectroradiometer (MODIS) imagery
- Aerial photography

Intertidal and Subtidal

- Ocean color imagery from SeaWiFS
- Aerial photography

Alaska Coastal Current

- Ocean color imagery from SeaWiFS
- MODIS ocean products

OCS/Alaska Gyre

- Ocean color imagery from SeaWiFS
- MODIS ocean products

6.2.6 Impact on GEM

Although the data standards set by the GEM program will be similar across the data sets in a given type, each data set will have its own set of standards and QC and ingest processing. As the GEM data management component becomes active, new data sets will be added to the archive. For each new data set, GEM will set data standards and create the software to perform the QC against those standards. The data management plan will outline what needs to be in place before a new data set can be added to the GEM archive

As each collection effort is funded and organized, a plan that outlines the data inventory and its submission schedule will be established. In addition, the plan will include the procedures for performing the QC process and how discrepancies will be resolved.

6.3 Characterizing the GEM User Community

During its lifetime, the GEM program will serve a large and diverse user community with needs that will vary from simple data download to the creation of tailored data and information products. In most cases meeting the requirements of particular user groups will require detailed analysis and the creation of tailored products, but generalizations can be made about the types of applications for which GEM will provide data.

The user groups interested in each application will have different levels of data analysis and reduction capabilities, and each will need to search for GEM data with different criteria. Some applications require regular or periodic access to GEM data, and others are irregular or sporadic. The largest discriminator between the applications, however, is the type of data products that GEM will create for them and the level of processing that will go into creating those products. The following applications are relevant for all four of the main GEM habitat themes: watersheds, intertidal and subtidal, ACC, and the Alaska gyre.

1. Basic research and analysis is perhaps the most fundamental application of GEM data. This activity will be done by researchers who are collecting data for GEM and by other researchers that are investigating the GEM region. In general, this community will have a good understanding of GEM data and will be searching for specific variables within a region of interest. Access is less likely to be irregular, but research applications expect access to data as soon as it can be made available; therefore, filet transfer protocol (ftp) or file-download of the original data will generally be sufficient.

2. Modeling is also a critical application of GEM data. Verbal and visual models will be drawn from research applications, but statistical and numeric models will require access to customized data products that are tailored to meet the needs of the model as closely as possible. Most of the search criteria may be saved by the system and may be reused on a regular basis to execute the model with the most recent set of parameters. The types of preprocessing could include reformatting, spatial or temporal aggregation, regridding, and reprojection.

3. Resource management applications will increase in number through time and may become a common use of GEM data. These applications will require a set of products separate from the modeling applications. Management applications will be both periodic and sporadic, and the products may include reports, graphs, or maps. Examples include regular stock analysis reports that are used by fisheries managers to set catch limits and or irregular access to watershed data that would be relevant to permit requests.

4. Public outreach encompasses several different applications that GEM will be supporting to varying degrees. These include providing public information about the state of the ecosystems that are being studied by GEM, as well as the general administration of the GEM program. Other outreach activities will include supporting educational programs and possibly emergency response. These applications can be supported with maps and graphs that describe various aspects of the central GEM themes. Access is likely to be quite irregular and may be accomplished through the creation of a few standard maps and graphs on a regular basis.

6.3.1 Supporting GEM Applications with User Interfaces

To support these applications, GEM will initially provide three different modes of access. The initial design will include basic search and download, tailored product creation and display, and open map access. For the most part, basic search and download will support research applications, tailored products will be used by both modeling and management applications, and open map access will support public outreach applications. Together these three modes of access characterize many of the scientific data delivery systems available on the Web.

Basic search and download is currently the most common method of accessing data on the Web. Many projects have an interface that makes some level of search available and then allows data to be downloaded by clicking through to an ftp site or a Web page containing data links. Examples include the following:

- CIIMMS (http://info.dec.state.ak.us/ciimms/), which has been used successfully to provide basic access to meta-data and data relating to Cook Inlet;
- Systems such as GLIMPSE (http://lternet.edu/data/), EMAP (http://www.epa.gov/emap/index.html), and Beija-flor (http://beija-flor.ornl.gov/lba/), which provide basic access for the NSF Long Term Ecological Research program, the EPA Environmental Monitoring and Assessment Program, and the Large Scale Biosphere-Atmosphere Experiment in Amazonia sponsored in part by NASA; and
- The GLOBEC program, which provides basic data download through its own database (http://globec.whoi.edu/globec-dir/data-access.html).

Although these systems provide different types of search criteria, and each has a different orientation, they all provide access to meta-data and, in most cases, the actual data collected by the program. The GEM program can use one of these systems or something very similar to provide access to data soon after it is submitted to GEM. Research applications are often focused on specific variables and regions,, and these basic systems meet the majority of those needs. In addition, a basic search-and-download tool will provide the minimum access to GEM data and may support the other applications, including modeling, resource management, and public outreach. Although budgetary constraints may require that the creation of custom map and data products be limited, the basic search-and-download functions will be supported as long as data is collected and archived by the GEM program.

The meta-database maintained to support the basic search-and-download functions would also support access to remote database services that are funded by or relevant to GEM. Remote databases like the EVOS hydrocarbon database and other databases maintained by the group that is conducting the data collection effort will be included in the GEM meta-database for searching purposes. The data will then be available through the remote Web site set up to support those data.

Map creation systems such as the Open GIS Consortium's Web Mapping Server (WMS) (http://www.opengis.org/techno/specs/01-047r2.pdf) and the ArcIMS system (http://www.esri.com/software/arcims/index.html) from the Environmental Systems Research Institute (ESRI) make preprocessed maps available to users on the Web. Both of these systems provide maps to Web browsers and to freely available viewers. Because the WMS protocol is not tied to any particular vendor, it has been enjoying rapid acceptance and use in a wide range of applications. In the future, the use of WMS in educational and outreach applications is likely to be very large.

Once GEM has identified a set of standard map products that would be useful to the public or to particular educational programs, they will be available through one of these Internet map protocols. These products will likely include base maps and general information maps, but might also include regular maps of the Alaska gyre or currents that affect the GEM habitats. Web sites designed to support the educational program or the public interests will display these maps and may, in time, support more complicated map viewers that can access and overlay maps from other sites that are relevant to the goal of the Web site.

Data products tailored to specific modeling and resource management applications will be the most useful facet of the GEM data distribution and also the most expensive to create. It is not possible to create a single data distribution system that meets the wide range of user needs in modeling and resource management. Therefore, GEM will need to prioritize the products that are needed by particular groups and create them in sequence. These products will be designed with the close involvement of the specific user community to which they are targeted and, initially, they may need to be created with a significant amount of manual effort. However, once automated, a separate Web-based interface that will be used by the target user group to create and download these products on a regular (or irregular) basis can be created. In the future, after many of these products have been designed and the distribution of them automated, certain common functions will emerge and GEM will begin to build a library of data-processing utilities.

Examples of modeling products include the reformatting and regridding of data to match the execution grid and time steps of the model. Non-GEM data may be pulled from another site and integrated into data products. Several different products may be generated at a time to meet the needs of a single modeling application. The creation of a suite of products may be done by hand and may require that GEM start with algorithms that were written by the modeling group itself. However, after the modeling group has used the products successfully several times, the process of creating the products could be automated and a simple interface built to allow the group to create and download the product. If the requirements for the product are clear enough, the manual step may be bypassed.

For resource management applications, a report or spreadsheet used to manage fish stocks may require access to several different data sets and the extraction and integration of different variables. Unless the report is already in existence, it may require several attempts before a truly useful product can be created. Once this is accomplished, the process could be automated. The resource management office could trigger the report through a simple interface created for that product. In this way, the application component of GEM will feedback information and tailor the design of the data management component.

In time, GEM will create a wide range of products to meet the specific needs of the GEM modeling and resource management communities. The creation of each product will involve GEM staff and the interaction with the target user group. Depending on the scope of the effort for each product, several tailored products could be created for the modeling and resource management community each year. These products, coupled with the basic search and download and the Web-based map delivery services, will support a wide range of both specific and general data distribution needs.

6.4 The Structure of the GEM Data System

The GEM data management system will address the issues related to the data types supplied by the observational component and the demand placed by the applications component. As such, the data management system is positioned between the other two components and must develop and maintain an interface to both. In addition, modeling and map creation applications will generate new data that will also be archived and delivered by the GEM data system.

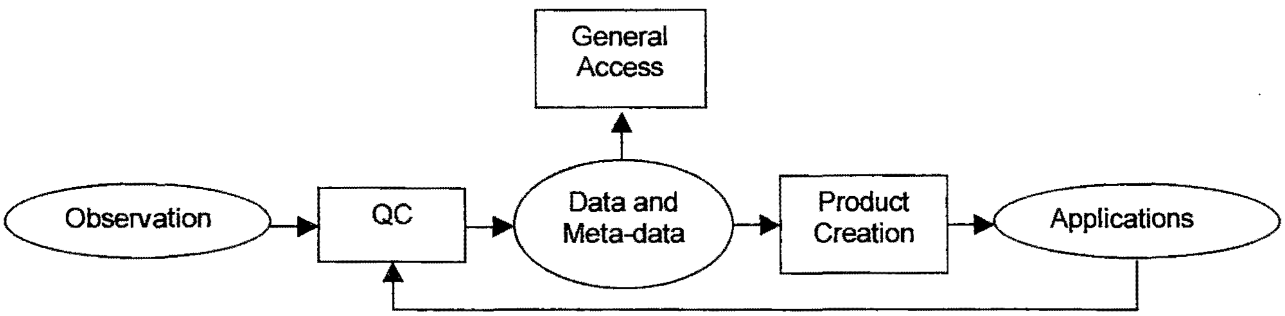

Figure 6.2 The GEM data system

6.4.1 Supply Side Support

To support the ingestion of data from the observational component of the GEM program, the data management system must provide QC of the meta-data (and to some degree the data) and quality assurance of the data and the meta-data. Quality control will ensure that the meta-data comply with GEM standards and that valid values are supplied in formats that can be used to store that data in the GEM archive. Values such as station identifier, date, and latitude and longitude need to be valid or fall within a reasonable range. In general, each data type will have unique issues, and the GEM program will create new QC procedures and programs. Through time however, some of the QC algorithms can be shared across data types. The GEM program will also need to provide QC on some of the data values, such as species identification, but the submitter will do most of the QC for the data itself. The validation provided by the data management component is done to ensure that data can be found and retrieved with the use of an accepted set of search criteria.

Quality assurance includes the design of the QC processes and documentation of the QC activity. The data management component of GEM will not be able to provide QC over most of the data, but it can ensure that the documentation of the submitters' QC is available along with the data. The data management system will also provide quality assurance of the meta-data.

6.4.2 Demand Side Support

On the applications side of the data management system, software modules will create the custom data products and standard maps. These routines will not be developed all at once when the system is deployed, but through time, as the archive is populated with data and the user demands become clear. Custom routines will integrate third-party software where possible. These external routines may be commercial off the shelf (COTS) software or they may come from the growing library of free software available on the Web. These custom routines will pull data sets from the GEM archive and other relevant data sources and provide preprocessing. Examples of the types of operations include:

- **Reformatting:** Often, raw data may need to be reorganized to be usable by an application. For example, an application may need multiple observations pulled into a single output file containing only those variables of interest from a subset of stations. This file may also need to be ordered by date or species and written out in a comma-separated file that can be manipulated by a spreadsheet. Other output formats may include GIS, image analysis formats or special binary formats for visualization applications.

- **Aggregation or subsetting:** Modeling applications often need summary or averaged data. These data sets may need to be merged or clipped to capture the temporal or spatial region of interest completely. Some file formats support clipping, but many of these routines will be tailored to the input data. Aggregation routines may come from the application space or they may simple average or sum calculations.

- **Projection:** Data are usually collected with latitude and longitude coordinates. Some regional models use a map projection that preserves spatial relationships more accurately for the region. Satellite data and other data may need to be projected or reprojected into a specific map projection for the application. Software is available to perform some of these reprojection operations from both commercial and freeware sources.

- **Map creation and visualization:** Some data products may be best represented in the spatial context of a map or a graph. The generation of these maps or the creation of a multidimensional or graph-oriented visualization requires data-extraction reduction and rendering. Many software utilities are available to assist in this process.

Most custom data products will require a user interface to allow the entry of parameters and trigger the creation of the product. In most cases, these interfaces will be simple Web pages that support various pull-down menus to select input or display parameters. Simple interfaces that are designed to support one or two data products are easier to use and maintain. Through time, however, GEM will support a large number of custom products, and interfaces may need to be merged to reduce the overall maintenance load.

6.4.3 Meta-Database Support

The core of the data system will be the meta-database and a data-storage component. The meta-database contains the descriptive information and is used to integrate access to the data by supporting cross-data set searching. The ability to search for all data sets within a given spatial or temporal range, or all data sets containing particular variables, requires a single meta-database. The QC routines will ensure that the meta-data submitted to the GEM program meets the standards necessary to support cross-data set search. No data set will be added to the system unless it can be located with a search of this meta-database.

The meta-database maintained by the GEM program will also support access to remote GEM archives that are maintained by individual researchers. The GEM program will also evaluate whether to ingest meta-data about data sets that are relevant to the GEM system, but are not directly supported by GEM. The ongoing gap analysis conducted by the GEM program will continue to reveal data sets and data-collection activities that complement the GEM mission. One of the GEM goals is to integrate with those projects. The data management system will reflect this integration by allowing users to locate relevant data that may not be archived by the GEM program.

Most search and download systems include some level of meta-database support. The GEM program will evaluate the use of these existing systems, including the structure of the meta-database. Because the population and use of the meta-database will be the central activity of the GEM data system, any existing system will need to be modified before it is used by GEM.

6.4.4 Data Storage

The storage of the data in files or in another storage mechanism is a separate function of the data system that in time will require a significant amount of storage space. The meta-database will contain pointers to the data itself, which may physically be in a separate storage facility. The evolution of large archive technology has been rapid in the last few years, but GEM will be able to postpone the use of tape or optical media for several years until the space requirements demand it. The GEM program will evaluate the use of an external site to store the data as well as the use of GEM computing hardware. Unlike the search of the meta-database that places a heavy computational burden on resources while returning a small amount of data, accessing the data itself requires no significant computation, but can return a large amount of data. Therefore, the network connectivity is also an evaluation criterion for the data storage subsystem.

The format of the data files will be defined and standardized in the GEM data management plan. Although the QC procedures will not validate the scientific quality of the data, these programs will need to validate the format of the data. Routines for creating data product require that input data files are in a recognizable format and contain data in a format that can be processed automatically.

6.4.5 GEM Administrative Support

Managing the projects funded by and associated with GEM requires a project-oriented database (see Chapter 6, Volume I). The administrative information includes the original proposal, comments submitted by the review panel, status reports and notes, and the final report. This information will be valuable in the long term as the data collected by the project is evaluated in retrospect. The proposals and reports will contain the original hypotheses, as well as the problems that were encountered during data collection. Future researchers will use this project history to understand the original goals of the project and issues that might affect data quality.

Much of these administrative data a\is in the public record and will be made available over the Web. The GEM meta-database will include the project specifications so that the data submitted by the project can be displayed along with the administrative details. This link between the administration of the project and the data submitted would also allow the GEM program to evaluate whether all the data for a given project have been submitted.

APPENDIX A. FISH AND INVERTEBRATE SPECIES FROM 1996 TRAWL SURVEY OF THE GULF OF ALASKA

The tables below provides the common and scientific names of fish and invertebrate species encountered during the 1996 Gulf of Alaska bottom trawl survey. The maximum depth of sampling was 500 meters.

Fish Species

Family	Species Name	Common Name
Lamnidae	*Lamna ditropis*	salmon shark
Squalidae	*Squalus acanthias*	spiny dogfish
	Somniosus pacificus	Pacific sleeper shark
Rajidae	*Raja binoculata*	big skate
	Bathyraja interrupta	Bering skate
	Raja rhina	longnose skate
	Bathyraja trachura	black skate
	Bathyraja parmifera	Alaska skate
	Bathyraja aleutica	Aleutian skate
Chimaeridae	*Hydrolagus colliei*	spotted ratfish
Bothidae	*Citharichthys sordidus*	Pacific sanddab
Pleuronectidae	*Atheresthes stomias*	arrowtooth flounder
	Atheresthes evermanni	Kamchatka flounder
	Hippoglossus stenolepis	Pacific halibut
	Hippoglossoides elassodon	flathead sole
	Lyopsetta exilis	slender sole
	Eopsetta jordani	petrale sole
	Parophrys vetulus	English sole
	Microstomus pacificus	Dover sole
	Glyptocephalus zachirus	rex sole
	Limanda asper	yellowfin sole
	Platichthys stellatus	starry flounder
	Psettichthys melanostictus	sand sole
	Lepidopsetta cf. sp. *bilineata*	northern rock sole
	Lepidopsetta bilineata	southern rock sole
	Isopsetta isolepis	butter sole

Fish Species

Family	Species Name	Common Name
Pleuronectidae (continued)	*Pleuronectes quadrituberculatus*	Alaska plaice
Agonidae	*Sarritor frenatus*	sawback poacher
	Xeneretmus leiops	smootheye poacher
	Bathyagonus pentacanthus	bigeye poacher
	Bathyagonus nigripinnis	blackfin poacher
	Podothecus acipenserinus	sturgeon poacher
	Aspidophoroides bartoni	Aleutian alligatorfish
	Hypsagonus quadricornis	fourhorn poacher
Ammodytidae	*Ammodytes hexapterus*	Pacific sand lance
Anarhichadidae	*Anarrhichthys ocellatus*	wolf-eel
Anoplopomatidae	*Anoplopoma fimbria*	sablefish
Argentinidae	*Nansenia candida*	bluethroat argentine
Bathylagidae	*Leuroglossus schmidti*	northern smoothtongue
Bathymasteridae	*Bathymaster caeruleofasciatus*	Alaskan ronquil
	Bathymaster signatus	searcher
Chauliodontidae	*Chauliodus macouni*	Pacific viperfish
Clupeidae	*Clupea pallasi*	Pacific herring
Macrouridae	*Albatrossia pectoralis*	giant grenadier
	Coryphaenoides cinereus	popeye grenadier
Cottidae	*Thyriscus anoplus*	
	Icelinus borealis	northern sculpin
	Icelinus tenuis	spotfin sculpin
	Gymnocanthus pistilliger	threaded sculpin
	Gymnocanthus galeatus	armorhead sculpin
	Artediellus sp.	
	Malacocottus zonurus	darkfin sculpin
	Hemilepidotus hemilepidotus	red Irish lord
	Hemilepidotus jordani	yellow Irish lord
	Hemilepidotus papilio	butterfly sculpin
	Triglops forficata	scissortail sculpin
	Triglops scepticus	spectacled sculpin
	Triglops pingeli	ribbed sculpin
	Triglops macellus	roughspine sculpin

Fish Species

Family	Species Name	Common Name
Cottidae (continued)	*Myoxocephalus polyacanthocephalus*	great sculpin
	Myoxocephalus jaok	plain sculpin
	Dasycottus setiger	spinyhead sculpin
	Psychrolutes paradoxus	tadpole sculpin
	Nautichthys pribilovius	eyeshade sculpin
	Nautichthys oculofasciatus	sailfin sculpin
	Rhamphocottus richardsoni	grunt sculpin
	Hemitripterus bolini	bigmouth sculpin
	Eurymen gyrinus	smoothcheek sculpin
	Icelus spiniger	thorny sculpin
Trichodontidae	*Trichodon trichodon*	Pacific sandfish
Gadidae	*Microgadus proximus*	Pacific tomcod
	Gadus macrocephalus	Pacific cod
	Theragra chalcogramma	walleye pollock
Hexagrammidae	*Ophiodon elongatus*	lingcod
	Pleurogrammus monopterygius	Atka mackerel
	Hexagrammos octogrammus	masked greenling
	Hexagrammos stelleri	whitespotted greenling
	Hexagrammos decagrammus	kelp greenling
Cyclopteridae	*Aptocyclus ventricosus*	smooth lumpsucker
	Eumicrotremus birulai	round lumpsucker
	Eumicrotremus orbis	Pacific spiny lumpsucker
	Careproctus melanurus	blacktail snailfish
	Careproctus gilberti	smalldisk snailfish
	Paraliparis sp.	
Melamphaeidae	*Poromitra crassiceps*	crested bigscale
Melanostomiidae	*Tactostoma macropus*	longfin dragonfish
Merluccidae	*Merluccius productus*	Pacific hake
Myctophidae	*Stenobrachius leucopsarus*	northern lampfish
	Diaphus theta	California headlightfish
	Lampanyctus ritteri	broadfin lanternfish
	Lampanyctus jordani	brokenline lampfish
Paralepidae	*Paralepis atlantica*	duckbill barracudina

Fish Species

Family	Species Name	Common Name
Osmeridae	*Thaleichthys pacificus*	eulachon
	Hypomesus pretiosus	surf smelt
	Mallotus villosus	capelin
	Spirinchus thaleichthys	longfin smelt
Salmonidae	*Oncorhynchus tshawytscha*	chinook salmon
	Oncorhynchus kisutch	coho salmon
	Oncorhynchus gorbuscha	pink salmon
	Oncorhynchus keta	chum salmon
	Oncorhynchus nerka	sockeye salmon
	Salvelinus malma	Dolly Varden
Cryptacanthodidae	*Cryptacanthodes giganteus*	giant wrymouth
Stichaeidae	*Lumpenus maculatus*	daubed shanny
	Lumpenus sagitta	snake prickleback
	Lumpenella longirostris	longsnout prickleback
	Chirolophis decoratus	decorated warbonnet
	Poroclinus rothrocki	whitebarred prickleback
Zaproridae	*Zaprora silenus*	prowfish
Zoarcidae	*Bothrocara pusillum*	Alaska eelpout
	Lycodes palearis	wattled eelpout
	Lycodes diapterus	black eelpout
	Lycodes brevipes	shortfin eelpout
	Lycodes pacificus	blackbelly eelpout
	Lycodapus sp.	
Scorpaenidae	*Sebastolobus alascanus*	shortspine thornyhead
	Sebastes aleutianus	rougheye rockfish
	Sebastes alutus	Pacific ocean perch
	Sebastes brevispinis	silvergray rockfish
	Sebastes ciliatus	dark dusky rockfish
	Sebastes cf. sp. *ciliatus*	light dusky rockfish
	Sebastes crameri	darkblotched rockfish
	Sebastes elongatus	greenstriped rockfish
	Sebastes entomelas	widow rockfish
	Sebastes flavidus	yellowtail rockfish

Fish Species

Family	Species Name	Common Name
Scorpaenidae (continued)	*Sebastes helvomaculatus*	rosethorn rockfish
	Sebastes maliger	quillback rockfish
	Sebastes melanops	black rockfish
	Sebastes nigrocinctus	tiger rockfish
	Sebastes paucispinis	bocaccio
	Sebastes pinniger	canary rockfish
Scorpaenidae	*Sebastes polyspinis*	northern rockfish
	Sebastes proriger	redstripe rockfish
	Sebastes ruberrimus	yelloweye rockfish
	Sebastes babcocki	redbanded rockfish
	Sebastes variegatus	harlequin rockfish
	Sebastes wilsoni	pygmy rockfish
	Sebastes zacentrus	sharpchin rockfish
	Sebastes borealis	shortraker rockfish
	Sebastes reedi	yellowmouth rockfish

Source: Martin, M. H. Data report: 1996 Gulf of Alaska bottom trawl survey. 1997. U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

Invertebrate Species

Phylum	Species/Taxon Name	Common Name
Cnidaria	*Cyanea capillata*	
	Alcyonium sp.	
	Gersemia sp.	sea raspberry
	Anthomastus sp.	
	Anthomastus sp. A	
	Anthomastus sp. B	
	Primnoa willeyi	
	Paragorgia arborea	
	Callogorgia sp.	
	Stylatula sp.	slender seawhip
	Pavonaria finmarchica	
	Ptilosarcus gurneyi	

Invertebrate Species

Phylum	Species/Taxon Name	Common Name
Cnidaria (continued)	*Metridium senile*	
	Liponemis brevicornis	
	Stylaster brochi	
	Cyclohelia lancellata	
	Errinopora sp.	
	Plumarella sp. 1	
	Thouarella sp.	
	Fanellia compressa	
	Muriceides sp.	
	Amphilaphis sp.	
	Arthrogorgia sp.	
Annelida	*Cheilonereis cyclurus*	
	Eunoe nodosa	giant scale worm
	Eunoe depressa	depressed scale worm
	Serpula vermicularis	
	Carcinobdella cyclostomum	striped sea leech
Arthropoda	*Balanus evermanni*	giant barnacle
	Balanus rostratus	beaked barnacle
	Pandalus jordani	ocean shrimp
	Pandalus borealis	northern shrimp
	Pandalus tridens	yellowleg pandalid
	Pandalus platyceros	spot shrimp
	Pandalus goniurus	humpy shrimp
	Pandalus hypsinotus	coonstripe shrimp
	Pandalopsis dispar	sidestripe shrimp
	Eualus macilenta	
	Lebbeus groenlandicus	
	Crangon communis	twospine crangon
	Crangon dalli	ridged crangon
	Crangon septemspinosa	sevenspine bay shrimp
	Argis dentata	Arctic argid
	Sclerocrangon boreas	sculptured shrimp
	Argis lar	kuro argid

Invertebrate Species

Phylum	Species/Taxon Name	Common Name
Arthropoda (continued)	*Pasiphaea pacifica*	Pacific glass shrimp
	Pasiphaea tarda	crimson pasiphaeid
	Cancer magister	Dungeness crab
	Cancer oregonensis	Oregon rock crab
	Cancer gracilis	graceful rock crab
	Pinnixa occidentalis	pea crab
	Oregonia gracilis	graceful decorator crab
	Chorilia longipes	longhorned decorator crab
	Chionoecetes tanneri	groved tanner crab
	Chionoecetes bairdi	bairdi tanner crab
	Chionoecetes angulatus	triangle tanner crab
	Hyas lyratus	Pacific lyre crab
	Pagurus brandti	sponge hermit
	Pagurus aleuticus	Aleutian hermit
	Labidochirus splendescens	splendid hermit
	Pagurus confragosus	knobbyhand hermit
	Pagurus dalli	whiteknee hermit
	Pagurus kennerlyi	bluespine hermit
	Pagurus ochotensis	Alaskan hermit
	Pagurus rathbuni	longfinger hermit
	Pagurus tanneri	longhand hermit
	Elassochirus tenuimanus	widehand hermit crab
	Pagurus capillatus	hairy hermit crab
	Elassochirus cavimanus	purple hermit
	Elassochirus gilli	Pacific red hermit
	Lopholithodes foraminatus	box crab
	Acantholithodes hispidus	fuzzy crab
	Lithodes aequispina	golden king crab
	Hapalogaster grebnitzkii	
	Rhinolithodes wosnessenskii	rhinoceros crab
	Paralithodes camtschaticus	red king crab
	Paralithodes platypus	blue king crab
	Placetron wosnessenskii	scaled crab

Invertebrate Species

Phylum	Species/Taxon Name	Common Name
Arthropoda (continued)	*Pugettia* sp.	kelp crab
	Munida quadrispina	
Mollusca	*Tochuina tetraquetra*	giant orange tochui
	Tritonia diomedea	rosy tritonia
	Chlamylla sp.	
	Cranopsis major	
	Natica clausa	arctic moonsnail
	Natica russa	rusty moonsnail
	Polinices pallidus	pale moonsnail
	Colus herendeenii	thin-ribbed whelk
	Volutopsius harpa	left-hand whelk
	Volutopsius fragilis	fragile whelk
	Beringius kennicottii	
	Beringius undatus	
	Neptunea amianta	
	Neptunea pribiloffensis	Pribilof whelk
	Neptunea lyrata	lyre whelk
	Plicifusus kroyeri	
	Volutopsius callorhinus	
	Aforia circinata	keeled aforia
	Fusitriton oregonensis	Oregon triton
	Bathybembix bairdii	
	Cidarina cidaris	
	Buccinum plectrum	sinuous whelk
	Buccinum scalariforme	ladder whelk
	Arctomelon stearnsii	Alaska volute
	Modiolus modiolus	northern horsemussel
	Mytilus edulis	blue mussel
	Chlamys rubida	reddish scallop
	Patinopecten caurinus	weathervane scallop
	Yoldia scissurata	crisscrossed yoldia
	Yoldia thraciaeformis	broad yoldia
	Nuculana sp.	

Invertebrate Species

Phylum	Species/Taxon Name	Common Name
Mollusca (continued)	*Limopsis akutanica*	Akutan limops
	Musculus niger	black mussel
	Musculus discors	discordant mussel
	Astarte crenata	crenulate astarte
	Tridonta borealis	boreal tridonta
	Cyclocardia ventricosa	stout cyclocardia
	Cyclocardia crebricostata	many-rib cyclocardia
	Clinocardium nuttallii	Nuttall cockle
	Clinocardium ciliatum	hairy cockle
	Clinocardium californiense	California cockle
	Mactromeris polynyma	Arctic surfclam
	Siliqua sp.	
	Serripes groenlandicus	Greenland cockle
	Serripes laperousii	broad cockle
	Pododesmus macroschisma	Alaska falsejingle
	Opisthoteuthis californiana	flapjack devilfish
	Octopus dofleini	giant octopus
	Rossia pacifica	eastern Pacific bobtail
	Berryteuthis magister	magistrate armhook squid
Echinodermata	*Evasterias troschelii*	
	Evasterias echinosoma	
	Orthasterias koehleri	
	Leptasterias hylodes	
	Rathbunaster californicus	
	Pycnopodia helianthoides	
	Stylasterias forreri	
	Lethasterias nanimensis	
	Pedicellaster magister	
	Poraniopsis inflata	
	Henricia sanguinolenta	
	Henricia leviuscula	
	Leptasterias polaris	
	Gephyreaster swifti	

Invertebrate Species

Phylum	Species/Taxon Name	Common Name
Echinodermata (continued)	*Hippasteria spinosa*	
	Pseudarchaster parelii	
	Mediaster aequalis	
	Ceramaster japonicus	red bat star
	Ceramaster patagonicus	orange bat star
	Luidia foliata	
	Solaster endeca	
	Solaster dawsoni	
	Solaster stimpsoni	
	Solaster paxillatus	
	Crossaster borealis	
	Crossaster papposus	rose sea star
	Lophaster furcilliger	
	Pteraster tesselatus	
	Pteraster militaris	
	Pteraster obscurus	
	Diplopteraster multipes	
	Asterias amurensis	purple-orange seastar
	Ctenodiscus crispatus	common mud star
	Leptychaster pacificus	
	Dipsacaster borealis	
	Luidiaster dawsoni	
	Strongylocentrotus droebachiensis	green sea urchin
	Strongylocentrotus franciscanus	red sea urchin
	Strongylocentrotus pallidus	white sea urchin
	Allocentrotus fragilis	orange-pink sea urchin
	Brisaster latifrons	
	Echinarachnius parma	Parma sand dollar
	Gorgonocephalus caryi	
	Asteronyx loveni	
	Ophiura sarsi	
	Amphiophiura ponderosa	
	Ophiopholis aculeata	

Invertebrate Species

Phylum	Species/Taxon Name	Common Name
Echinodermata (continued)	*Parastichopus californicus*	
	Molpadia intermedia	
	Pentamera lissoplaca	
	Bathyplotes sp.	
	Cucumaria fallax	
	Stichopus japonicus	
	Psolus fabricii	
Porifera	*Suberites ficus*	hermit sponge
	Aphrocallistes vastus	clay pipe sponge
	Mycale loveni	tree sponge
	Halichondria panicea	barrel sponge
	Myxilla incrustans	scallop sponge
	Hylonema sp.	fiberoptic sponge
Bryozoa	*Eucratea loricata*	feathery bryozoan
	Flustra serrulata	leafy bryozoan
Brachiopoda	*Terebratalia transversa*	
	Terebratulina unguicula	
	Laqueus californianus	
Chordata	*Styela rustica*	sea potato
	Boltenia sp.	
	Halocynthia aurantium	sea peach
	Aplidium sp.	
	Synoicum sp.	
	Molgula retortiformis	sea clod
	Molgula griffithsii	sea grape

Source: Martin, M. H. Data report: 1996 Gulf of Alaska bottom trawl survey. 1997. U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

APPENDIX B. NORTH PACIFIC MODELS OF THE ALASKA FISHERIES SCIENCE CENTER AND SELECTED OTHER ORGANIZATIONS

Descriptions of Model Hypotheses

Descriptions compiled by Kerim Aydin (Kerim.Aydin@noaa.gov). A list of references is provided at the end.

Single-Species Stock Assessment Models That Include Predation

So far we have developed two of these models: one for Eastern Bering Sea pollock (Livingston and Methot 1998) and one for Gulf of Alaska pollock (Hollowed et al. 2000). We might develop one for Aleutian Islands Atka mackerel in the future. The purpose of these models is to better understand the sources and time trends of natural mortality for pollock by explicitly incorporating predation mortality induced by their major predators into an age-structured fish stock assessment model. We have learned that not only is natural mortality at younger ages much higher than that for adults, but that it varies across time, depending on time trends in predator stocks. This finding about mortality has given us better ideas of what influences predation has on fish recruitment through time and helps us to separate predation and climate-related effects on recruitment. We can better show the demands of other predators such as marine mammals for a commercially fished stock and how it might influence the dynamics of that stock (although we still need to make progress in understanding the effects on the marine mammals).

Bering Sea Multispecies Virtual Population Analysis (MSVPA)

We now have a multispecies virtual population analysis (MSVPA) model for the Bering Sea (Livingston and Jurado-Molina, 2000). This model includes predation interactions among several commercially important groundfish stocks and also predation by arrowtooth flounder and northern fur seal on these stocks. This model can give us a better idea of the predation interactions among several stocks. We can use outputs from this type of model to help us understand what the possible multispecies implications are of our single-species-oriented fishing strategies. Results from these forecasting exercises show that a particular fishing strategy may have the opposite effect of the intended effect if multispecies interactions are taken into consideration. We have also done multispecies forecasting with this model by using different hypotheses about regime shifts and associated fish recruitment patterns.

Boreal Migration and Consumption Model (BORMICON) for the Eastern Bering Sea

We have an initial version of a spatially explicit model of pollock movement and cannibalism in the Eastern Bering Sea. We hope to better understand the differences in spatial overlap of predators and prey and how that affects the population dynamics of each. The model we have modified for the Bering Sea is one being used in other boreal ecosystems, BORMICON (Boreal Migration and Consumption Model). Migrations are prescribed currently with the hope that we can prescribe movement based on physical factors in the future. The influence of spatial overlap of cannibalistic adult pollock with juveniles on the population dynamics of pollock is investigated. Hypotheses about larval drift positions and the resulting overlap and cannibalism are also being explored. This model could be linked in the future to an individual-based larval pollock model and to a nutrient-phytoplankton-zooplankton model that could prescribe zooplankton abundance by area as alternate food for adults and as the primary food for juveniles.

Analytical Approach to Evaluating Alternative Fishing Strategies with Multiple Gear Types

The analytical approach for simulating current groundfish management in the North Pacific U.S. Exclusive Economic Zone involves considering interactions among a large number of species (including target, nontarget, and prohibited) areas, and gear types. To evaluate the consequences of alternative management regimes, modeling was used to predict the likely outcome of management decisions by using statistics on historical catch of different species by gear types and areas. Management of the Alaska groundfish fisheries is complex, given the large numbers of species, areas, and gear types. The managers schedule fisheries openings and closures to maximize catch subject to catch limits and other constraints. These management actions are based on expectations about the array of species likely to be captured by different gear types and the cumulative effect that each fishery has on the allowable catch of each individual target species and other species groups. Management decisions were simulated by an in-season management model that predicts capture of target and nontarget species by different fisheries based on historical catch data by area and gear type. The groundfish population abundance for each alternative regime was forecast for a 5-year period beginning from the present. This approach provides a reasonable representation of the current fisheries management practice for dealing with the multi-species nature of catch in target fisheries.

In addition to the model and its projected results, agency analysts also used the scientific literature, ongoing research, and the professional opinion of fishery experts in their respective fields to perform qualitative assessments.

Influence of Advection on Larval Pollock Recruitment

This model investigates the environmental relationship between surface advection during the post-spawning period (pollock egg and larval stages) and pollock survival. Wespestad et al. (1997) found that during years when the surface currents tended north-north westward along the shelf that year class strength was improved compared to years when currents were more easterly. They used the OSCURS surface advection model to simulate drift. Subsequently (Ianelli et al. 1998), their analysis was extended to apply within a stock assessment model. The model uses surface advection during a 90-day period to determine the "goodness" of the advective field for juvenile pollock.

Shelikof Pollock Individual-Based Model (IBM)

This IBM Model was designed to run in conjunction with the 3-D physical model (SPEM) and the Shelikof nutrient-phytoplankton-zooplankton model. Its purpose is to examine, at a mechanistic level, hypotheses about recruitment of pollock in Shelikof Strait, especially as they refer to transport, growth ,and (somewhat) mortality of pollock from spawning through the fall of the 0-age year.

Global Ocean Ecosystem Dynamics (GLOBEC) Nutrient-Phytoplankton-Zooplankton (NPZ) 1-D and 3-D Models

This modeling effort (the 3-D NPZ model coupled with a physical model of the circulation of the region) is designed to test hypotheses about the effect of climate change/regime shifts on production in the coastal region of the Gulf of Alaska, including effects on cross-shelf transport, upstream effects, local production, and effect on suitability of the region as habitat for juvenile salmon.

Steller Sea Lion Individual-Based Model (IBM)

This IBM model will be designed to examine how sea lion energy reserves change, through foraging and bioenergetics, depending on the distribution, density, patchiness, and species composition of a dynamic prey field (as influenced by factors such as potential local depletion by fishing). It should be applicable to any domain surrounding a specific sea lion rookery or haul-out in the Bering Sea, Aleutian Islands, or Gulf of Alaska. Lion characteristics such as age, location, life stage, and birth date are recorded. Caloric balance is the main variable followed for each individual.

Shelikof Nutrient-Phytoplankton-Zooplankton (NPZ) Model, 1-D and 3-D Versions

This NPZ model was designed to produce a temporally and spatially explicit food source (Pseudocalanus stages) for larval pollock, designed to be input to the pollock IBM model. This set of coupled (biological and physical) models was designed to be used to examine hypotheses about pollock recruitment in the Shelikof Strait region.

Gulf of Alaska Walleye Pollock Stochastic Switch Model

This model was designed as a mathematical representation of a conceptual model presented in Megrey et al. 1996. It is a numerical simulation model of the recruitment process. A generalize description of stochastic mortality is formulated as a function of three specific mortality components considered important in controlling survival (random, caused by wind mixing events, and caused by prevalence of oceanic eddies). The sum total of these components, under some conditional dependencies, determines the overall survival experienced by the recruits.

North Pacific Ecosystem Model for Understanding Regional Oceanography (NEMURO):

This model was designed to represent the minimum state variables needed to represent a generic nutrient-phytoplankton-zooplankton (NPZ) marine ecosystem model for the North Pacific. Ecosystem fluxes are tracked in both units of nitrogen and silicon. Carbon flux process equations have been recently added. The purpose of the model is to examine the effects of climate variability on the marine ecosystem through regional comparisons by means of using the same ecosystem model structure and process equations.

Mass-Balance Ecosystem Models (Ecopath) for North Pacific Regions of Interest (Multiple Models)

Mass-balance food web models provide a way for evaluating the importance of predator-prey relationships, the roles of top-down and bottom-up forcing in modeled ecosystems, and the changes in ecosystem structure resulting from environmental perturbations (natural or anthropogenic). Additionally, the models may provide a way to compare natural predation mortality with respect to predator biomass and fishing levels, and determine the quality of data available for a given system.

Eastern Bering Sea Shelf Ecopath Model 1. Although many of these models were done in the past for the Alaska region, the most up-to-date published model is the effort by Trites et al. (1999) for the Eastern Bering Sea. These models are highly aggregated across age groups and species groups and best highlight our gaps in understanding of how ecosystems function and our lack of data on certain ecosystem components. Walleye pollock is broken into two biomass groups: pollock ages 0 to 1 and pollock age 2 and older. This model is useful for testing ecosystem hypotheses about bottom-up and top-down forcing and to examine system level properties and energy flow among trophic levels. The Eastern Bering Sea model extent includes the main shelf and slope areas north to about 61° N and excludes near-shore processes and ecosystem groups.

Eastern Bering Sea Shelf Model 2 and Western Bering Sea Shelf Ecopath Model. The second Eastern Bering Sea Shelf model breaks down the earlier model into more detailed species groupings to tease apart the dynamics of individual species, especially in the commercially important groundfish. Spatial extensions to the model include subdividing into inner, middle, and outer biophysical domains. The model will be calibrated with respect to top-down and bottom-up forcing with the use of "checkpoint" food webs for several years in the 1990s, the 1979 to 1998 time series of trawl data, and Multispecies Virtual Population Analysis (MSVPA)/other assessment analyses. The primary purpose of this model is to investigate the relative role of natural and anthropogenic disturbances on the food web as a whole. A Western Bering Sea Shelf model, built as a joint U.S.-Russian project, is currently being completed.

Gulf of Alaska , Continental Shelf, and Slope (Excluding Fjord, Estuarine, and Intertidal Areas) Ecopath Model. Throughout the 1990s there have been extensive commercial fisheries in the Gulf of Alaska (GOA) for groundfish, as well as crab, herring, halibut, and salmon. Removals of both target species and bycatch by these (and historical) fisheries have been suggested as a possible cause for the decline of the western stock of Stellar sea lions, which are now listed as endangered species. An Ecopath/Ecosim model for the GOA could test the hypothesis that fishery removals of groundfish and bycatch during the 1990s has contributed to the continued decline of Stellar sea lions.

In addition, a community restructuring, in which shrimp populations declined dramatically and commercial fish populations increased between the 1960s and the 1990s, may have taken place, according to small mesh trawl surveys conducted by the National Marine Fisheries Service and Alaska Department of Fish and Game. An additional hypothesis, which could be tested with this model, is that this trophic reorganization has had a negative impact on marine mammal and bird populations in the GOA. Finally, the effects of an apparent increase in shark populations on their prey and the relative importance of these effects in the whole system could be evaluated with an Ecopath model.

The Aleutian Island and Pribilof Islands Ecopath Models. While the Eastern Bering Sea and Gulf of Alaska model may capture broad-scale dynamics of widespread fish stocks, their scale is too large to address local depletion. This issue may be important for island-based fish such as Atka mackerel, and may be critical for determining the effect that changes in the food web may have on the endangered Steller sea lion. This smaller-scale Ecopath model will be used in conjunction with larger-scale models to examine the possibility of linking the models across scales.

Prince William Sound Ecopath Models. An Ecopath model of Prince William Sound (PWS) was constructed by a collaboration of experts from the region during 1998-1999 (Okey and Pauly 1999). The *Exxon Valdez* Oil Spill Trustee Council funded this effort for the purpose of "ecosystem synthesis." The project was coordinated by the University of British Columbia Fisheries Centre and overseen by the National Marine Fisheries Service Office of Oil Spill Damage Assessment and Restoration. Prince William Sound is well defined geographically; spatial definition of the system consisted of drawing lines across Hinchenbrook Entrance, Montague Strait, and smaller entrances. The time period represented by the model is 1994 to 1996, s the post-spill period with the broadest and most complete set of ecosystem information. This food web model consists of 48 functional groups ranging from single ontogenetic stages of special-interest species to highly aggregated groupings. A variety of hypotheses are being addressed with the PWS model—most relate to the 1989 *Exxon Valdez* Oil Spill and the fisheries in the area.

Table 1. Model Areas Time Period, Contact Person, and Model Status

Model Name/ Model Region	Time Period	Contact	Status
Single-species stock assessment models that include predation	EBS: 1964-95 GOA: 1964-97 (Annual)	Patricia Livingston	Working
Bering Sea MSVPA	1979-98 3 Months (quarterly)	Patricia Livingston Jesus Jurado-Molina	Working
BORMICON for the eastern Bering Sea	1979-97 1 Month	Patricia Livingston	Planning/ construction
Evaluating Alternative Fishing Strategies	Current	Jim Ianelli	Working
Advection on larval pollock recruitment	90 Days of Larval Drift 1970s-present	Jim Ianelli	Working
Shelikof Pollock IBM	YD 60-270 Daily	Sarah Hinckley	Working
GLOBEC NPZ 1-D and 3-D Models	YD 60-270 (eventually year-round). Daily	Sarah Hinckley	In progress
Steller Sea Lion IBM	Summer or Winter, Minutes to Days	Sarah Hinckley	Planning/ Construction
Shelikof NPZ Model, 1-D and 3-D Versions	YD 60-270 (eventually year-round). Daily	Sarah Hinckley	In progress
GOA Pollock Stochastic Switch Model	32 years (replicates) Daily	Bern Megrey	Working
NEMURO	1 Full Year, Daily	Bern Megrey	In progress
Eastern Bering Sea Shelf Model 1 Ecopath	1950s and early 1980s Annual	Patricia Livingston	Completed
Eastern Bering Sea Shelf Model 2 Ecopath	1979-1998 Annual	Kerim Aydin	In progress
Western Bering Sea Shelf Ecopath	Early 1980s Annual	Kerim Aydin Victor Lapko	In progress
Gulf of Alaska Shelf Ecopath	1990-99 Annual	Sarah Gaiches	In progress
Aleutian Islands, Pribilof Islands Ecopath	1990s-2000s Annual	Patricia Livingston Lorenzo Ciannelli	Proposed
Prince William Sound, Ecopath	Pre- and Post 1989 oil spill Annual	Tom Okey	Completed

Notes:
BORMICON = Boreal Migration and Consumption Model
EBS = Eastern Bering Sea
GLOBEC = Global Ocean Ecosystem Dynamics
GOA = Gulf of Alaska
MSVPA = Multispecies Virtual Population Analysis
NEMURO = North Pacific Ecosystem Model for Understanding Regional Oceanography
NPZ = nutrient-phytoplankton-zooplankton
YD = days of the year

Table 2. Model Spatial Domains, Currencies, Inputs, and Outputs

Model Name/ Model Region	Model Spatial Domain	Inputs	Outputs/Currency
Single-species stock assessment models that include predation	Across EBS and GOA Pollock distributions	Fisheries data and predator biomass	Pollock population and mortality trends—number at age (and biomass at age)
Bering Sea MSVPA	The modeled region is the EBS shelf and slope north to about 61°N	Fisheries, predator biomass, and food habits data. This model requires estimates of other food abundance supplied by species outside the model.	Age-structured population dynamics for key species—numbers at age
BORMICON for the Eastern Bering Sea	The model is spatially explicit with 7 defined geographic regions that have pollock abundance and size distribution information.	Temperature is included and influences growth and consumption.	Spatial size distribution of pollock
Evaluating Alternative Fishing Strategies	U.S. Exclusive Economic Zone	Gear-specific fishing effort, including bycatch	Biomass of managed fish species
Advection on larval pollock recruitment	Southeast Bering Sea Shelf	OSCURS surface currents (wind-driven).	Index of pollock recruitment
Shelikof Pollock IBM	Western GOA from just southwest of Kodiak Island to the Shumagin Islands, shelf, water column to 100 m	From physical model: Water velocities, wind field, mixed-layer depth, water temperature, and salinity, Pseudocalanus field (from NPZ model)	Individual larval characteristics such as age, size, weight, location, life stage, hatch date, consumption, respiration
GLOBEC NPZ 1-D and 3-D Models	Water column (0-100 m) Coastal GOA from Dixon Entrance to Unimak Pass, 100 m of water column over depths < 2000 m 5-m depth bins x 20 km horizontal grid	Irradiance, MLD Temperature, diffusivity, bottom depths, water velocities (u, v, w	Diffusivity, ammonium, nitrate, detritus, small and large phytoplankton, dinoflagellates, tintinnids, small coastal copepods, neocalanus, and euphausiids (nitrate and ammonium): mmol/m^3 (all else): mg carbon/m^3
Steller Sea Lion IBM	Should be applicable to any domain surrounding a specific sea lion rookery or haul-out in the Bering Sea, Aleutian Islands, or GOA	The main input will be a 3D field of prey (fish) distribution, derived either from hypothetical scenarios or (later) modeled based on acoustic data	Individual sea lion characteristics such as age, location, life stage, and birth date are recorded. Caloric balance is the main variable followed for each individual.

Table 2. Model Spatial Domains, Currencies, Inputs, and Outputs

Model Name/ Model Region	Model Spatial Domain	Inputs	Outputs/Currency
Shelikof NPZ Model, 1-D and 3-D Versions	Water column (0-100 m), GOA from southwest of Kodiak Island to Shumagin Islands. 1-m depth bins for 1-D version; 1 m depth x 20 km for 3-D version	Irradiance, MLD, temperature, bottom depths, water velocities (u, v, w).	Nitrogen, phytoplankton, Neocalanus densities, Pseudocalanus numbers/m-3 for each of the 13 stages (egg, 6 naupliar, 6 copepodite)s
GOA Pollock Stochastic Switch Model	Shelikof Strait, Gulf of Alaska	Number of eggs to seed the model. Base mortality, additive and multiplicative mort. Adjustment parameters for each mort. Factor.	Number of 90-day-old pollock larvae through time
NEMURO	Ocean Station P (50°N 145°W), Bering Sea (57.5°N 175°W), and Station A7 off the east of Hokkaido island, Japan (41.3°N 145.3°W)	15 state variables and parameters, including 2 phytoplankton, 3 zooplankton, and multiple nutrient groups	Ecosystem fluxes are tracked in units of nitrogen and silicon.
Eastern Bering Sea Shelf Model 1 Ecopath	500,000 km^2 in EBS south of 61°N	Biomass, production, consumption, and diet composition for all major species in each ecosystem	Balance between produced and consumed per area biomass (t/km^2). Future work will explore energy (kcal/km^2) and nutrient dynamics.
Eastern Bering Sea Shelf Model 2 Ecopath	500,000 km^2 in eastern Bering Sea south of 61°N		
Western Bering Sea Shelf Ecopath	300,000 km^2 on western Bering Sea shelf		
Gulf of Alaska Shelf Ecopath	NPFMC management areas 610, 620, 630, and part of 640		
Aleutian Islands, Pribilof Islands Ecopath	Not determined		
Prince William Sound Ecopath	Whole Prince William Sound		

Table 2. Model Spatial Domains, Currencies, Inputs, and Outputs

Model Name/ Model Region	Model Spatial Domain	Inputs	Outputs/Currency

Source: Table 2 in "North Pacific Models of the Alaska Fisheries Science Center and selected others," compiled by Kerim Aydin

Notes:
BORMICON = Boreal Migration and Consumption Model
EBS = Eastern Bering Sea
GLOBEC = Global Ocean Ecosystem Dynamics
GOA = Gulf of Alaska
km = kilometer
kcal = kilo calorie
m = meter
MLD =
mmol = millimolar
MSVPA = Multispecies Virtual Population Analysis
NEMURO = North Pacific Ecosystem Model for Understanding Regional Oceanography
NPFMC = North Pacific Fisheries Management Council
NPZ = nutrient-phytoplankton-zooplankton
OSCURS = Ocean Surface Current Simulations
t = metric ton
YD = days of year

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APPENDIX C. GULF ECOSYSTEM MONITORING AND RESEARCH (GEM) DATABASE

Editorial notes: Needs a map of the GOA showing the locations of the most important ongoing marine science projects. Needs a description of monitoring projects in the database that are directed at human activities, following the outline of human activities in Chapter 2. Some of the information under GAP Analysis: Summary could be abstracted to tables or histograms. Projects of Interest to GEM needs further editing.
"Projects of interest to GEM" section refers to Table of titles of gap analysis database projects that needs to be prepared for the appendix. After discussion we decided we still need this for the reference of the reviewers and serious readers (such as us).

C.1 Current Information Gathering

C.1.1 The Gap Analysis Database: Introduction

The conceptual foundation in Chapter 4 (Volume II) has been shaped largely by currently available scientific information. Much of this information is derived from the monitoring and research activities conducted in the GOA and adjacent waters during the past 100 years. Information from these activities has been included in a database titled "Ongoing and Historical Monitoring and Research Activities in the Gulf of Alaska and Adjacent Waters." This database is referred to as the "gap analysis database" because it is used as a tool to assess past and current activities to set priorities and promote collaboration in filling important "gaps" in information, while avoiding duplication. Compiling this comprehensive database is a challenge in itself, given multiple funding sources and the dynamic nature of various appropriations processes, as well as a lack of information about the relationships among various programs and projects.

The database includes both ongoing and historical projects concerned with information gathering, processing, and applications in resource management and other areas of marine science. Projects in the database include readily identifiable research and monitoring activities, such as the NMFS biennial (triennial) trawl survey, the International Pacific Halibut Commission longline survey, and the National Weather Service data buoy network. The record for each project includes information on project purpose, types of data, expected project duration, contact information, Web site, and latitude and longitude for field activities. Not all categories of information in each record are complete, but a description of the basic functions of each project is available in each record. Because the "project" was not intended to be a standard unit for defining effort in marine research, the broad analysis below should be considered a qualitative comparison of the relative amounts of effort devoted to each category. The database is available in File Maker Pro, but can be made available in other formats, such as Excel and Access.

C.1.2 The Gap Analysis Database: Summary

Projects in the gap analysis database have been categorized as either monitoring or synthesis and research. For the purposes of the gap analysis, monitoring is routine data gathering based on assumptions about ecosystem behavior or how the measures capture system behavior. Monitoring is not expected to be completed within a fixed time frame. Examples of monitoring measurements are salinity, temperature, concentration of DDT, and populations of species at seabird colonies. For the purposes of the gap analysis, synthesis and research is defined as a time-limited activity that investigates relationships among ecosystem components with the use of data according to a specific experimental design. The synthesis and research category includes retrospective analysis, modeling, ecosystem process studies, and data management and information transfer. Each general activity category is further classified into six areas of study:

1. Birds, fish, and shellfish;
2. Physical and biological oceanography;
3. Freshwater water quality;
4. Contaminants;
5. Multiple topics; and
6. Other.

Monitoring

The majority (58%) of 291 projects in the gap analysis database as of May 2001 are classified as monitoring functions. Most of the monitoring functions address commercially, culturally, or socially important large animals, as identified below in percentages of all projects in the database:

- 20% fish and shellfish;
- 9% multiple topics;
- 7% mammal; and
- 4% seabird.

The balance of the monitoring projects are devoted exclusively to the small plants and animals and the physical and chemical measurements, shown below as percentages of all projects in the database:

- 15% physical oceanography with some chemical and biological;
- 1% freshwater;
- 1% biological oceanography;
- 1% contaminants; and
- < 1% other.

Monitoring projects for fish and shellfish are largely directed at single species or closely related aggregates of species such as salmon, halibut, rockfish, and crab. Mixed studies combine large animals, smaller fish, plankton, and sometimes contaminants, although detecting trends in the abundance of large animal species appears to be the primary purpose of the mixed surveys. Physical oceanography projects are dominated by satellite telemetry.

The ADF&G fields the largest number of fish and shellfish projects in the northern GOA, primarily for salmon and crab and, to a lesser extent, rockfish and other species. Long annual time series data collected by ADF&G are available from ADF&G for salmon and crab catches and for salmon spawners (escapements) in most major watersheds. Long annual time series exist for trawl survey data for shrimp, groundfish, and crab. Other substantial salmon data sets are age, weight, and length of adult salmon in catches. Other ADF&G projects record characteristics such as genetics, presence of disease, and other biological data.

More detailed information is available in Section C.2 of this appendix and the gap analysis database.

Synthesis and Research

About 42% of the projects in the gap analysis database are synthesis and research activities. These activities are listed below as percentages of all projects in the database:

- 22% data management and information transfer;
- 11% retrospective analysis;
- 5% modeling; and
- 3% ecosystem process studies.

The synthesis and research activities are further defined below as numbers of projects, because the small number of projects in some categories makes comparison of percentages problematic.

Data Management and Transfer

- 21 physical oceanography and atmospheric data;
- 2 benthic intertidal;
- 1 biological oceanography;
- 8 bird;
- 5 contaminant;
- 7 fish;
- 8 mammal;
- 6 mixed tissue archives for large animals and biological and physical data; and
- 2 freshwater and watershed oriented.

Retrospective Analysis

- 6 physical oceanography;
- 8 mixed (physical and biological);
- 1 mammal;

- 1 human use (subsistence);
- 9 fish;
- 2 contaminant;
- 2 bird;
- 1 biological oceanography; and
- 1 benthic intertidal.

Modeling

- 1 benthic intertidal;
- 3 mammal;
- 1 mixed (coupled biophysical); and
- 8 physical oceanography.

Ecosystem Process Studies. Relatively few (nine) ecosystem process studies are currently ongoing in the GOA. Four are being conducted in Glacier Bay in the more southern end of the GOA. Others are more relevant, looking at oceanographic forcing of primary productivity and productivities of fish.

C.1.3 Projects of Interest to GEM

The federal government is the primary funding source for the current information gathering programs of interest to the development of the GEM program, with substantial funding also provided by state government, foreign governments, and non-governmental organizations. The work is conducted within programs and projects too numerous to list here; however, a reference on the specific agencies and programs is provided in Section C.2 of this appendix. Relevant projects cover three broad categories:

1. Bird, fish, and mammal data and some human impacts associated with their harvests, collected by the primary fish and wildlife resource management entities;
2. Biological and other oceanographic observations, collected as part of major research efforts; and
3. Physical and chemical characteristics of waters and habitats collected by the primary state and federal agencies providing environmental monitoring.

Information on birds, fish, and mammals in watersheds and the nearshore marine areas is relatively abundant. Because data were collected through time for a variety of purposes and with a variety of methods, however, the usefulness for a long-term program such as the GEM program will need to be assessed on a case-by-case basis. Ongoing programs collecting animal data of particular interest to the GEM program are continuous, annual time series (in excess of 50 years) on commercial species such as salmon, fur, seals, and halibut, and shorter time series (some discontinuous) of around 30 to 50 years on other species of fish and shellfish, seabirds, and marine mammals. Observations on marine-related terrestrial animals and vegetation are available from grid surveys in the Chugach National Forest.

The longest continuous-time series of physical oceanographic measurements (temperature and salinity) in the GEM region is located outside the mouth of Resurrection Bay near Seward. Shorter time series of other variables have been collected at this location, known as Gulf of Alaska 1 (GAK1), by the Institute of Marine Science (IMS), University of Alaska Fairbanks (UAF), during the last three decades. Other ongoing oceanography programs initiated within the last 20 years provide important data sets. The Fisheries and Oceanography Coordinated Investigations (FOCI), initiated in the 1980s, was the first program in the western GOA to model physical oceanographic processes to understand changes in annual abundance of a marine fish species, pollock. Initiated in the 1990s, the Ocean Carrying Capacity (OCC) program is collecting data on the distribution of juvenile salmon on the continental shelf in the GOA and Bering Sea. Also initiated in the 1990s, the Global Ocean Ecosystem Dynamics (GLOBEC) program combines retrospective studies of existing data with observations of plankton, physical and chemical oceanography, and juvenile salmon abundance in PWS and the adjacent continental shelf and shelf break. GLOBEC is of particular interest to the GEM program because it seeks to understand how natural forces bring about changes in biological productivity, including that of salmon.

Other longer time series of observations of biological and physical oceanography from ongoing programs in the marine environment include the work of the Japan Fisheries Agency, which has been taking oceanographic observations in the GOA since the 1950s. Observations of the distributions of North American and Asian stocks of salmon and catches of groundfish species (pollock and cod) in the GOA by the International North Pacific Fisheries Commission and its successor, the North Pacific Anadromous Fish Commission (NPAFC), are extensive; however annual time series are not all complete. Although located very far to the south in the GOA, Canada's Ocean Station P continues to provide a continuous record of oceanographic observations now more than five decades long.

Daily time series (some discontinuous) of oceanographic and atmospheric data relevant to GEM planning are available, with most of the observations from the past decade. An array of buoys in the northern GOA operated by the National Weather Service (NWS) and the National Oceanographic Data Center (NODC) of NOAA provides atmospheric and physical oceanographic measurements of relevance to GEM planning. In addition, the satellite remote sensing projects of both NOAA and the National Aeronautics and Space Administration (NASA) provide cloud cover and sea surface observations throughout the GEM region.

Of immediate interest to GEM are ongoing projects to characterize the physical and chemical characteristics of waters and habitats collected by the primary environmental monitoring concerns: U.S. Geological Survey (USGS), ADEC, and EPA. Long-time-series measurements of freshwater runoff from stream gauges in major rivers of Southcentral Alaska are available from USGS, although the future of this program appears to be in doubt. ADEC has ongoing time series of water quality in the GEM region and is responsible for implementation of the EPA stations for the marine Environmental Monitoring and Assessment Program (EMAP) in the northern GOA.

C.2 List of Project Titles by Organization

Note that projects shared among agencies may be listed more than once.

Alaska Department of Environmental Conservation (ADEC)

184 Monitoring Programs for Paralytic Shellfish Poison (PSP) in King Crab, Dungeness Crab and Tanner Crab
236 Certified Shellfish Beaches
239 Contaminated Sites Database
240 Leaking Underground Storage Tank (UST) Sites in Alaska

Alaska Department of Fish and Game (ADF&G)

153 Sonar Enumeration of Returning Adult Salmon
154 Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes
155 Groundfish Port Sampling
156 Whiskers (Seals and Sea Lions)
157 Harbor Seal Survey
158 Weirs and Counting Towers for Enumeration of Returning Adult Salmon, Escapement
159 Aerial / Foot Surveys of Spawning Streams, Salmon Escapement
160 Fry / Smolt Outmigration
161 Salmon AWL (Age, Weight. Length)
162 Rockfish Assessments - Southeast Alaska
163 Rockfish Habitat Study - Southeast Alaska
164 Rockfish Jig Survey - Historical Dataset, 1980-1984
165 Sablefish Assessments, Southeast Alaska
166 Catch Sampling - Southeast Alaska (Rockfish, Sablefish, Lingcod), Prince William Sound and Lower Cook Inlet (Rockfish, Sablefish, Pacific Cod, Pollock), Kodiak and Aleutian Islands (Rockfish)
167 Fish Tickets for Shoreside Landings
168 Limnology - Lower Cook Inlet
169 Herring Dive Surveys - Prince William Sound and Southeast Alaska
170 Herring Aerial Surveys - Statewide
171 Herring Catch Sampling - Statewide
172 Pot Surveys - Southeast Alaska King Crabs
173 Trawl Surveys - Prince William Sound, Lower Cook Inlet, and Alaska Peninsula for King and Tanner Crabs
174 Dive Surveys - Southeast Alaska Clams, and Sea Cucumbers
175 Shellfish Dockside Sampling - Statewide
176 Shellfish Catch Enumeration - Statewide
177 Trident Basin Water Temperature
178 Shellfish Onboard Observers
179 Kodiak Red King Crab Tags
180 Gulf Pot Surveys - Crabs
181 Shrimp Trawl Surveys

183 Subsistence Harvest
185 Scallop Dredge Survey - Prince William Sound and Cook Inlet
186 Tanner Crab (Cook Inlet), King Crab (Cook Inlet), Dungeness Crab (Prince William Sound), and Pot Shrimp (Prince William Sound) Tagging - Historical Data Sets
187 Fish Pathology Disease History Database
188 Coded Wire Tag Database
189 Atlas to the Catalog of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes
190 Sport Fish Weirs and Sonars
191 Coded Wire Tagging (CWT) of Hatchery and Selected Wild Salmonid Stocks
192 Oil Spill Health Task Force
193 Sociopolitical Consequences of Offshore Oil Development
194 Community Profile Database
195 Population Survey of Organochlorine Contaminants in Alaskan Steller Sea Lions
196 Steller Sea Lion Surveys
197 Su-Hydro Beluga Whale Survey
235 Kitoi Bay Monitoring
254 Enumeration and estimation of commercial salmon harvests
255 Enumeration and estimation of sports salmon harvests
256 Shelikof Strait bottomfish trawl survey
276 Community Pattern Assessment
282 Abundance and Trend of Harbor Seal Populations: Haulout patterns and movement
283 Abundance and Trend of Harbor Seal populations: Index site counts at Tugidak Island
285 Harbor Seal Habitat
286 Health and Condition of Harbor Seal populations
287 Food Habits of Harbor Seals
288 Life History/General Biology of Harbor Seals
289 Vital Rates of Harbor Seals
291 Measuring Abundance and Trend of Harbor Seal Populations: Glacial Survey Methodology

ADF&G and National Marine Fisheries Service (NMFS)

282 Abundance and Trend of Harbor Seal Populations: Haulout patterns and movement
291 Measuring Abundance and Trend of Harbor Seal Populations: Glacial Survey Methodology

ADF&G and National Marine Mammals Lab (NMML)

288 Life History/General Biology of Harbor Seals
289 Vital Rates of Harbor Seals

Alaska Department of Health and Social Services (ADHSS)

182 Use of Traditional Foods in a Healthy Diet in Alaska: Risks in Perspective
198 Twenty Years of Trace Metal Analysis of Marine Mammals: Evaluation and Summation of Data from Alaska and Other Arctic Regions

Alyeska Service Corporation
253 Valdez Arm Environmental Monitoring

Center for Alaskan Coastal Studies
270 Coast Walk program for Kachemak Bay

Cook Inlet Keeper
237 Lower Kenai Peninsula Watershed Health Project
238 Citizens Environmental Monitoring Program (CEMP)

Faculty of Fisheries Hokkaido University (Japan)
292 Cruise of the T/S *Oshoro Maru* in the Gulf of Alaska

Fisheries and Oceans Canada
225 Line P / Station P
228 High Seas Salmon Program
229 A continuous plankton recorder monitoring program for the eastern North Pacific & southern Bering Sea (also UAF 257)

International Pacific Halibut Commission (IPHC)
030 Pacific Halibut Stock Assessment

Moss Landing Marine laboratories (MLML)
200 Dissolved Iron Data Set for the World Ocean from Moss Landing Marine Laboratories

National Aeronautics and Space Administration (NASA)
031 Sea-viewing Wide Field-of-view Sensor (SeaWiFS)
032 Moderate Resolution Imaging Spectrometer (MODIS)
033 Earth Observing System Data Information System (EODIS)
034 Advanced Earth Observation Satellite - NASA Scatterometer (ADEOS-NSCAT)
035 Sensory Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies (SIMBIOS)
036 Advanced Very High Resolution Radiometer (AVHRR)
037 Advanced Earth Observing Satellite (ADEOS) II - Sea Winds 1B
038 AIRS/AMSU/MHS
039 EOS - ALT
040 Quick Scatterometer (QuikSCAT) - SeaWinds Instrument
041 TOPEX/Poseidon
042 Coastal Zone Color Scanner (CZCS)

National Environmental Satellite, Data and Information Service (NOAA—NESDIS)
005 General Circulation and Tide Measurements / Model Output for the Coastal U.S.
007 Advanced Very High Resolution Radiometer (AVHRR)
044 Sea Surface Temperature 14 Km Analysis (Local-Scale) from NOAA Series AVHRR Data
045 Arctic and Southern Ocean Sea Ice Concentration

046 Global Temperature Salinity Profile Pilot (GTSPP) Program Database
047 NOAA Marine Environmental Buoy Database
048 Sea Surface Temperatures at Gulf of Alaska Light Stations (1959-1967)
049 U.S. Coastal Advanced Very High Resolution Radiometer (AVHRR) Data Products
050 Robinson-Bauer Numerical Atlas of Monthly Surface Layer
051 Intertidal Organisms and Habitats (F030) Data (1974-1980)
052 Herring Survey Population Density and Distribution (F057) Data (1976-1977)
053 Marine Birds of Coastal Alaska and Puget Sound (F031, F033, F034, F038, F040, F041)
054 The 14-km SST Fields from the NOAA TIROS/N Satellite Series
231 Sea Level Data, Wind Speed, and Significant Wave Height from Satellite Altimetry

National Institute of Standards and Technology (NOAA--NIST)
111 National Biomonitoring Specimen Bank (NBSB)
112 Benthic Survey and Mussel Watch
279 Marine Monitoring Quality Assurance Program

National Marine Fisheries Service (NOAA--NMFS)
008 Fishes of Alaska (book)
009 Winter Assessment of Shelikof Strait Spawning Pollock
010 North Pacific Domestic Groundfish Observer Database
011 Steller Sea Lion Count Database
012 Pacific Salmon Genetic Database Development
018 NMFS Longline Survey of the Aleutian Region, Bering Sea, and Gulf of Alaska
019 Life History Monitoring of Pink Salmon Biology
020 North Pacific Ocean Salmon Ecology
021 Retrospective Studies
022 Monitoring
055 Long Term Population Monitoring of Natural Populations of Seven Species of Salmonids
056 Comparisons of Walleye Pollock, Theragra chalcogramma, Harvest to Steller Sea Lion, Eumetopias jubatus, Abundance in the Bering Sea and Gulf of Alaska
057 Annual Survey of Cook Inlet Beluga Whales
058 Biennial Survey of Eastern North Pacific Ocean Gray Whales
059 Abundance of Pelagic Delphinids and Harbor Porpoise off the Coast of Alaska
060 MMPA Harbor Seals minimum population estimates
061 Sablefish Longline Survey
062 Ichthyoplankton Database
063 West Gulf of Alaska Pacific Cod Survey
064 Gulf of Alaska Biennial Survey (formerly Gulf of Alaska Triennial Survey)
065 Japan-US Cooperative Longline Survey of the Aleutian Region, Bering Sea, and Gulf of Alaska (also includes the data from the ongoing NMFS longline survey conducted in same general area)
066 Bycatch, Utilization, and Discards in the Commercial Groundfish Fisheries of the Gulf of Alaska,m Eastern Bering Sea, and Aleutian Islands
067 Shellfish and Groundfish Pathogens
068 Shelikof Strait FOCI

069 Gulf of Alaska Thornyhead Rockfish Stock Assessment
070 Ocean Surface Current Simulator (OSCURS)
071 North Pacific Foreign Fishery Groundfish Observer Database
072 Marine Mammal Protection/Endangered Species Acts Compliance
073 Cook Inlet Set and Drift Gillnet Marine Mammal Observer Project
074 Marine Mammal Health and Stranding Response Program (MMHSRP) Data Base
075 National Marine Mammal Tissue Bank (NMMTB)
077 Alaska Marine Mammal Stock Assessments
078 Pacific Marine Mammal Stock Assessments
079 Master Oceanographic Observational Data Set (MOODS); Extensive Oceanographic Profile Data, All Oceans
080 Genetic Stock Identification (GSI) of Pacific Salmon in Mixed Stock Fisheries
081 Marine Invertebrate Pathology
082 Marine Mammal Health and Stranding Response Program (MMHSRP) - Monitoring and Quality Assurance
083 Fin Rot
084 Fish Pathology
085 U.S. Commercial and Recreational Fisheries Statistical Data from NOAA National Marine Fisheries Service, Fisheries Statistics and Economics Division
086 West Coast Upwelling Indices Data Files
103 Bering Sea FOCI
137 Checklist for Bird Observations from the Eastern North Pacific Ocean, 1955 - 1967
226 Rockfish Genetic Database Development
245 Chiniak Bay Current Meter Mooring
246 Hatch timing of Tanner crabs (Chionoecetes bairdi) in Kodiak
247 Trident Basin (Kodiak) Extended Water temperature and Secchi Depth
248 Womens Bay Dive Logs and Crab Observations
249 Eastern Bering Sea Temperature Monitoring
268 Pavlof Bay Temperature Recording Mooring
269 Pavlof Bay Annual Shrimp Trawl Survey
277 Biomonitoring Component of the MMHSRP
278 Stranding Network--Marine Mammal Health and Stranding Response Program
280 Marine Mammal Analytical Quality Assurance
284 Stock Identification of Harbor Seal populations
290 Human Interactions with Harbor Seals

National Ocean Service (NOAA—NOS)

001 National Status and Trends Data Base
023 GLOBEC Northeast Pacific Program: Retrospective Analysis of Growth Rate and Recruitment for Sablefish, Anoploma fimbria, from the Gulf of Alaska and the California Current System
024 GLOBEC Northeast Pacific Program: Analysis of Ichthyoplankton Abundance, Distribution, and Species Associations in the Western Gulf of Alaska
025 GLOBEC Northeast Pacific Program: Long-term Variability in Salmon Abundance in the Gulf of Alaska and California Current Systems

026 GLOBEC Northeast Pacific Program: A Retrospective Study of Top Predator Trophic Positions, Productivity, and Growth in the Gulf of Alaska for 1960-75 and 1975-90
027 GLOBEC Northeast Pacific Program: Patterns, Sources and Mechanisms of Decadal-Scale Environmental Variability in the Northeast Pacific: A Retrospective and Modeling Analysis
028 GLOBEC Northeast Pacific Program: Remote Sensing of the Northeast Pacific: Retrospective and Concurrent Time Series Analysis Using Multiple Sensors on Multiple Scales
029 GLOBEC Northeast Pacific Program: Physical-Chemical Structures, Primary Production and Distribution of Zooplankton and Planktivorous Fish on the Gulf of Alaska Shelf
043 Marine Mammals of Coastal Alaska Data (1976-1991): Census (F025); Activity (F026): Pathology (F127)
087 Fish Kills in Coastal Waters: 1980-1989
088 Development of an Ecological Characterization of the Kachemak Bay Watershed
089 Sea-Viewing Wide Field-of-View Sensor (SeaWiFS) - Algorithms
090 National Benthic Surveillance Project
091 Mussel Watch Project
092 Specimen Banking Project
093 Using Cytochrome P450 to Monitor the Aquatic Environment: Initial Results from Regional and National Surveys. Marine Environmental Research. 34: 195-
094 Advanced Very High Resolution Radiometer (AVHRR) - Algorithms
199 GLOBEC Northeast Pacific Program: Retrospective Analysis of Northeast Pacific Microzooplankton
224 GLOBEC Northeast Pacific Program: Coupled Bio-Physical Models for the Coastal Gulf of Alaska
233 GLOBEC Northeast Pacific Program: Coupled Bio-physical Models for the Coastal Gulf of Alaska
234 GLOBEC Northeast Pacific Program: Retrospective Analysis of Northeast Pacific Microzooplankton: A Window on Physical Forcing of Food Web Structure
251 Kachemak Bay National Estuarine Research Reserve KBNERR

National Weather Service (NOAA—NWS)

004 Buoy Observations
095 Coastal-Marine Automated Network (C-MAN)
096 Moored Buoys
097 SeaBreeze CD-ROM

Ocean and Atmospheric Research (NOAA—OAR)

006 The Comprehensive Ocean-Atmosphere Data Set (COADS)
098 Distribution an Elemental Composition of Suspended Matter in Alaskan Coastal Waters
099 Long-Term Variations in Alaskan Salmon Abundance Determined from Sediment Core Analysis
100 On Exchange of Water Between the Gulf of Alaska and the Bering Sea through Unimak Pass

101 Gulf of Alaska CTD Data Collected under the Environmental Services Data and Information Management (ESDIM) Data Rescue
102 Bering Sea and Gulf of Alaska Winds (1946-1982)
104 Revised: Analysis of Allozyme Variation in Asian and Alaskan Pink Salmon
105 Intra-and Interspecific Genetic Variation of mtDNA in Rockfish (Sebastes)
106 Physical-Chemical Structures, Primary Productivity and Distribution of Zooplankton and Planktivorous Fish on the Gulf of Alaska Shelf: A GLOBEC Monitoring Proposal Project: Energetics Project
107 Historical Analysis of Sockeye Scales
108 Retrospective Analysis of the Effects of Trawling on Benthic Communities in the Gulf of Alaska and Aleutian Island Region
109 Long-Term Variations in Alaskan Sockeye Salmon Abundance
110 Monitoring Transport in the Alaska Coastal Current: A Feasibility Study

National Science Foundation

113 Improvement in the Curation of the University of Alaska Frozen Tissue Collection
114 A Flora of the Benthic Marine Algae of Alaska: Phase 1, An Inventory of the Existing Collections
115 Flux and Fate of Sediment and Water from Small Mountainous Rivers to the Continental Margin: the Gulf of Alaska Example.
116 Gulf of Alaska Recirculation Study (GARS)
117 Upper Ocean Circulation in the Subpolar and Northern Subtropical Pacific

Pacific States Marine Fisheries Commission (PSMFC)

232 Salmonid Coded Wire Tag Database

Prince William Sound Regional Citizens' Advisory Council (PWSRCAC)

241 Long-Term Environmental Monitoring Program

Prince William Sound Science Center (PWSSC)

201 Long-term Killer Whale Database

U.S. Department of the Interior (DOI)

002 Age and Length Characteristics of Rainbow Trout in Selected Streams
003 Alaska Seabird Inventory and Monitoring Plan
013 Sea Otter Biomonitoring Program
014 Seabird Tissue Archival and Monitoring Project (STAMP)
015 Bald Eagle Database
016 Coastal Studies
017 Hydrologic Data Collection and Investigations
076 Alaska Marine Mammal Tissue Archival Project (AMMTAP)
118 Forage Fish Assessment of the Cook Inlet Oil and Gas Development-Affected Areas
119 Kachemak Bay Experimental and Monitoring Studies
120 The Alaskan Frozen Tissue Collection and Associated Electronic Database: A Resource for Marine Biotechnology

121 Spring Survey of Steller's Eiders in the Gulf of Alaska
122 Monitoring and Evaluating Effects on Seabird Colonies in Potential Oil and Gas Development Areas
123 Sediment Quality in Depositional Areas of Shelikof Strait and Outermost Lower Cook Inlet
124 Mapping of Cook Inlet Tide Rips Using Local Knowledge and Remote-Sensing Imagery Techniques
125 Historical Data Sets for Prince William Sound Ecosystem: Implications of Changing Climate
126 Ecological Processes Underlying the Large Spatial and Temporal Variance in Distribution and Abundance of Species in Glacier Bay. Part 1: The Spatial Distribution of Small Schooling Fish and Associated Predators in Glacier Bay, and Their Relationship to Oceanographic and Bathymetric Parameters
127 Seabird Population Dynamics and Food Supply: Assessing Long-Term Changes in Alaska Marine Ecosystem
128 Prince William Sound Ecosystem Initiative
129 Harbor Seal Monitoring in Glacier Bay National Park and Preserve
130 Pacific Coho Salmon Study
131 Marine Mammal Marking, Tagging and Reporting Program
132 Sea Otter Stock Assessment
133 Alaska Seabird Inventory and Monitoring Plan - Annual Monitoring Sites
134 Beringian Seabird Colony Catalog
135 Wintering Marine Bird and Mammal Surveys
136 Nongame Migratory Bird Project - Boat Survey Data in Bays and Sounds
139 Genetics Research for Characterizing Alaskan Salmonid Populations
140 Seasonal Movements and Pelagic Habitat Use of Alaska Seabirds Determined by Satellite Telemetry
141 Fishes of Alaska
142 Design and Implementation of a Seabird Monitoring Database for the North Pacific
143 Assessment of Sea Otter Population Status in Alaska
144 Ecological Processes Underlying the Large Spatial and Temporal Variance in Distribution and Abundance of Species in Glacier Bay. Part 1: The Spatial Distribution of Small Schooling Fish and Associated Predators in Glacier Bay, and Their Relationship to Oceanographic and Bathymetric Parameters
145 Population Status and Ecology of Shorebirds in Alaska
146 Using Genetic Markers to Determine Population Status and Management Strategies of Mammals
147 Pelagic Seabird Atlas of the North Pacific
149 IHN Virus Strain Differentiation and Field Epidemiology in Salmonids
150 Watershed Ecosystem Studies
151 Marine Geology of Benthic Biohabitats in Glacier Bay, Alaska
152 Cook Inlet Basin Study Unit
223 Alaska Seabird Inventory and Monitoring Plan - Periodic Monitoring Sites
227 Population Ecology of Seabirds on Middleton Island, Alaska
230 Process Structuring Coastal Marine Communities in Alaska: DOI Trust Resources

242 National Wetlands Inventory (NWI)
243 Pelagic Distribution and Abundance of Seabirds and Marine Mammals
244 Seabird Population Dynamics and Food Supply: Assessing Long-Term Changes in Alaska Marine Ecosystem
252 Management of Subsistence Resources in Alaska
271 Alaska Seabird Colony Catalog Database
272 Subsistence Harvest of Migratory Birds
273 Distribution and Abundance of Kittlitz's Murrelets and Black Oystercatcher in western PWS
274 Harbor seal surveys on the coast of Kenai Fjords National Park, 1979 to 1998
275 Human Impacts on Nesting Shorebirds on the Coast of Kenai Fjords National Park
281 Assessment of Sea Otter Population Status in Alaska

U.S. Global Change Research Program (USGCRG)
214 Repeat Hydrography and Special Analysis Centre
215 One-Time Survey: Cruise 17N
216 Subsurface Floats
217 Surface Drifting Buoys
218 Joint Archive for Shipboard Acoustic Doppler Current Profilers (ADCP)
219 Upper Ocean Thermal Data
220 Sea Surface Salinity
221 Surface Meteorological Data and Surface Fluxes
222 Tide Gauges

United Nations (UN)
210 Permanent Service for Mean Sea Level (PSMSL) and Global Sea Level Observing System (GLOSS)
211 Ships of Opportunity Program (SOOP): Low Density Expendable Bathythermograph Network (XBT)
212 Array for Real-Time Geostrophy (ARGO)
213 Pacific Basinwide Extended Climate Study (P-BECS)

University of Alaska Fairbanks (UAF)
202 Data set for the NOAA Advanced Very High Resolution Radiometer Satellite (AVHRR)
203 Advanced Very High Resolution Radiometer (AVHRR) Imagery From UAF HRPT (High Resolution Picture Transmission) Station
204 MSL-622 Satellite Oceanography Project
205 Institute of Marine Science, University of Alaska Fairbanks Database; Physical, Chemical, Biological and Geological Data
206 Isotope Ratio Studies of Marine Mammals in Prince William Sound
207 GAK 1 TIME SERIES
257 A continuous plankton recorder monitoring program for the eastern North Pacific & southern Bering Sea
258 A basin-wide retrospective analysis of growth and survival patterns in pink and chum salmon

259 Pilot study on the use of airborne lidar and digital imagery for surveys of epipelagic fish and associated biological features in the southeastern Bering Sea and North Pacific Ocean
260 Assessing the physiological stress of Steller sea lions using fecal hormone analysis
261 Determining survival and long-term foraging behavior of juvenile Steller sea lions through implanted, satellite-linked mortality transmitters
262 Availability and use of prey by Steller sea lions in the Kodiak area
263 Process modeling of the Alaska Coastal Current
264 Physical forcing of marine productivity: monitoring moorings on the Gulf of Alaska shelf
265 Estimating seabird diets using fatty acids: protocol development and testing of ReFER hypotheses as tested in the Bering Sea
266 A cooperative effort between Alaska Native people & federal agencies on marine mammal & bird stranding
267 Harbor seal biological sampling: expanding the scope of the subsistence archival project Cook Inlet, Kodiak, Aleutian Islands

University of Miami

208 University of Miami TIROS-N-NOAA AVHRR Level 1b

University of Rhode Island

209 University of Rhode Island Advanced Very High Resolution Radiometer (AVHRR) Level 1b

U.S. Department of Agriculture—Forest Service (USFS)

250 Grid Survey System

APPENDIX D. GLOSSARY OF EXISTING AGENCY PROGRAMS AND PROJECTS

Glossary of Existing Agency Programs and Projects

Introduction

Most major information-gathering programs of the NPRB area are divisible into three major categories: large animals or macrofauna (birds, mammals, fish, shellfish), oceanography (physical, chemical, geological and biological) and human use (land and water use, water quality, contaminants). The Alaska Department of Fish and Game, the U.S. Department of the Interior and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service are the primary monitoring agencies for macrofauna. Sampling efforts for macrofauna are typically focused on regional or smaller areas, including PWS, Cook Inlet, Kodiak and the Alaska Peninsula. The National Aeronautics and Space Administration and the National Oceanic and Atmospheric Administration are the primary sources of oceanographic data, including data on zooplankton, phytoplankton and primary productivity. Notably absent are monitoring or assessment programs for large plants, such as kelp and other large marine algae. Oceanography programs often include the NPRB region as part of a larger program. The U.S. Environmental Protection Agency, U.S. Forest Service, Alaska Department of Environmental Conservation and Alaska Department of Natural Resources all monitor certain human uses of lands and waters and the impacts of human use on resources, as do several nongovernmental organizations.

A summary of the major programs conducted by the United States, State of Alaska, transboundary organizations and nongovernmental organizations follows. These programs have been incorporated into a database, which will include projects that are actively collecting data as well as projects that are no longer active. Inactive projects contain considerable valuable historical information relevant to the production of plants and animals in the NPRB region. Appendix E contains a reference list of commonly used acronyms and web site links for these programs and others.

State of Alaska

Alaska Department of Community and Economic Development (ADCED)

Each year, the department's Division of Tourism publishes Alaska Visitor Arrivals and the Alaska Visitor Industry Economic Impact Study. These studies are based on secondary data. No field surveys have been conducted since the 1993-1994 Alaska Visitor Statistics Program III.

Alaska Department of Environmental Conservation (ADEC)

The Division of Air and Water Quality (AWQ) is concerned with public health and environmental problems throughout Alaska. The Year 2000 statewide water quality assessment is a project to describe the nature, status and health of Alaska's waters, and to identify restoration and protection needs. The AWQ also monitors ambient water quality through the State Water Discharge Permits and Certification program and the Non-Point Source Water Pollution Control program. Discharge permits, such as that for the Alyeska Marine Terminal in Valdez, require that the permitee monitor both surface water and ground water for such contaminants as petroleum, PCBs and heavy metals. Monitoring data from about 3,000 sites statewide (1,000 of which are in the oil spill region) are stored in the Contaminated Sites Database. The Non-Point Source Water Pollution Control program keeps a list of "impaired water bodies," that is, water bodies that do not meet state water quality standards. ADEC also funds non-point source water pollution monitoring projects with funds authorized by Congress under Section 319 of the Clean Water Act and administered by the Environmental Protection Agency (EPA).

ADEC has awarded EPA 319 funds to several citizen-based monitoring programs, such as the Cook Inlet Keeper's water monitoring program in lower Cook Inlet, the Kenai Watershed Forum, and wetlands studies by the Nature Conservancy. In partnership with other agencies, ADEC is developing a bioassessment project in the Cook Inlet bioregion. This project seeks to develop protocols for water sampling that are better suited to conditions in Alaska than the current sampling protocols.

ADEC is a partner in implementing the EPA's Environmental Monitoring and Assessment Program (EMAP) in southcentral Alaska (2001) and southeastern (2002). The purposes of the EMAP program are to provide a comprehensive report card on the status of the ecological resources nationwide and to detect trends in these resources.

ADEC and ADNR are partners with the EVOSTC in the development of the regional information system known as The Cook Inlet Information Management and Monitoring System (CIIMMS). CIIMMS is a project, funded by the Trustee Council, to develop a website for finding, contributing and sharing information for the Cook Inlet watershed region. CIIMMS is intended to support monitoring, management and restoration of natural resources, in addition to data sets and software relevant to understanding the ecological status of this region.

The Division of Environmental Health routinely tests and certifies clams from commercially harvested shellfish beaches and shellfish farms for paralytic shellfish poisoning (PSP). The division also monitors PSP in king crab in PWS and in Dungeness crab and Tanner crab in PWS, Cook Inlet and Kodiak Island. The Contaminated Sites program monitors superfund sites, abandoned military sites and other contaminated sites throughout the state.

Alaska Department of Fish and Game (ADFG)

The Division of Commercial Fisheries does substantial monitoring of salmon and other anadromous fish species, herring, crabs, shrimp and several other invertebrate species, and some species of mammals. ADFG is responsible for the NPRB region portion of the Coded Wire Tag database, which contributes to understanding ocean distributions of salmon. The department's point of sales (fish ticket) information supports understanding of abundance and distribution of salmon, crabs, herring, and other species. ADFG has extensive historical information on the distribution of some species of crab and shrimp in the NPRB region. ADFG has archives of scales and size at age from salmon and herring that enable understanding of historical marine growth regimes.

An extensive archive of genetic data on chum, sockeye and other species of salmon is being assembled by ADFG in cooperation with NMFS and agencies of nations participating in the North Pacific Anadromous Fish Commission (NPAFC). The data enhance understanding of the oceanic distribution of salmon, and thereby contribute to understanding oceanic regime shifts. ADFG also conducts genetic research on crabs, some rockfish, herring, and pollock.

The ADFG and cooperating regional aquaculture associations also collect some physical and biological oceanographic data, such as Kodiak nearshore sea surface temperatures, Kitoi Bay zooplankton biomass (Kodiak), and PWS zooplankton settled volumes.

The ADFG Subsistence Division's Whiskers database on subsistence harvest of marine mammals is part of a larger NOAA sponsored program. In addition, the Wildlife Conservation Division monitors harbor seals in cooperation with NMFS.

The Sport Fish Division conducts port sampling of groundfish for information about the recreational effort, catch and harvest of rockfish, lingcod and halibut in the northern NPRB region. This project consists of catch sampling and angler interviews. The Subsistence Division collects data on subsistence fish and shellfish harvest. The Habitat Division monitors the effect of certain activities on anadromous fish streams. Since 1990, the division has been monitoring compliance with the Alaska Forest Practices regulations on private land. Since 1998, the Habitat Division has been researching the effects of stream crossing structures on fish habitat and fish passage on the Kenai Peninsula. Note that most ADFG marine programs serve to provide information to NOAA programs.

Alaska Department of Health & Social Services (ADHSS)

The Division of Public Health has conducted several retrospective studies of contamination in subsistence foods. One study examined 20 years of data on trace metal analysis in marine mammals and another examined the occurrence of contaminants in subsistence foods, with an emphasis on methylmercury, cadmium and PCB levels.

Alaska Science and Technology Foundation (ASTF)

The ASTF was established in 1988 by the Governor and the State of Alaska Legislature. It's purpose is "to promote and enhance, through basic and applied research and the development and commercialization of technology, economic development and technological innovation in Alaska; public health; telecommunications; and the sustained growth and development of Alaskan scientific and engineering capabilities."

Alaska Department of Natural Resources (ADNR)

The ADNR monitors certain uses of land and resources on state lands and waters. The Division of Oil and Gas performs field inspections of activities on state oil and gas leases. The Division of Forestry monitors compliance with the terms of state timber sales. The Division of Parks and Outdoor Recreation tracks use of state-owned recreation facilities such as campgrounds, cabins and parking facilities. Periodically, staff inspects these facilities. The Division of Mining, Land and Water issues aquatic farming permits, shore fishery leases and other permits and leases for use of state-owned tidelands and uplands. The Division maintains statistics on the number of applications submitted and issued and monitors compliance with terms and conditions of permits and leases.

University of Alaska

The university has extensive programs that are relevant to NPRB. Four federally and state supported programs within the university system are expected to provide the International

Arctic Research Center substantial expertise and information of interest: the School of Fisheries and Ocean Sciences, the Sea Grant Program, the National Underwater Research Program, and the Institute of Social and Economic Research.

Institute of Marine Science (IMS) School of Fisheries and Ocean Sciences: Scientists associated with IMS have compiled much of the historical data relevant to the NPRB program. IMS produced the comprehensive review (Rosenberg 1972) in preparation for the extensive and intensive environmental studies sponsored by the Minerals Management Service in the 1970s (Hood and Zimmerman 1986). The IMS maintains a historic database of oceanographic measurements from the NPRB region, and it currently operates the R/V Alpha Helix, a 133-foot research vessel, for the National Science Foundation.

Pollock Conservation Cooperative Research Center (PCC) School of Fisheries and Ocean Sciences (SFOS): The SFOS operates the PCC Research Center that was established in February 2000 and seeks to improve knowledge about the North Pacific Ocean and Bering Sea through research and education, focusing on the commercial fisheries of the Bering Sea and Aleutian Islands. For the 2000 funding cycle, the PCC Research Center is especially interested in trying to improve knowledge through research and education relating to climate regime shifts and interannual variability in the Bering Sea ecosystem; the recovery of the Steller sea lion, including the identification of factors contributing to its decline; bycatch in the fisheries (for example, bycatch of salmon); and the impact of fishing activities on ecosystem dynamics and the diversity and abundance of target and non-target species. Funding for the PCC Research Center is provided by members of the PCC, a fishing cooperative of companies that operate catcher/processors in the Bering Sea and Aleutian Islands pollock fishery.

International Arctic Research Center (IARC): IARC promotes international collaboration in global change research in the arctic. In the science plan for IARC, key elements are understanding the relative contributions of natural and manmade causes to climate change, understanding what to measure in order to detect changes, and predicting the impacts of change on humans. The IARC Research Framework has eight themes, four of which are relevant to the NPRB program: 1) detection of contemporary changes, 2) arctic paleoclimatic and paleoenvironmental reconstructions, 3) impacts, consequences of change and education, and 4) integration of research on a regional scale.

United States Government

Federal Partnership Programs

Marine Environmental Health Research Laboratory (MEHRL): MEHRL is an interdisciplinary environmental laboratory operated by NOAA, NIST, the University of Charleston, the Medical University of South Carolina, and the South Carolina Department of Natural Resources. It is a model of state-federal cooperation in marine environmental research dedicated to providing the information needed to sustain the health, productivity and diversity of marine resources. The interdisciplinary program is designed to provide answers to complex problems surrounding the health of coastal marine resources.

National Ice Center (NIC): The National Ice Center is a multi-agency operational center partnered by the Department of Defense (Navy--Naval Ice Center), the Department of Commerce

(NOAA—National Weather Service and National Environmental Satellite Data Information Service), and the Department of Transportation (U.S. Coast Guard). NIC ice data are a key part of the U.S. contribution to international global climate and ocean observing systems.

National Oceanographic Partnership Program (NOPP): NOPP is a legislatively-mandated collaboration of 12 U.S. government agencies designed to promote cooperative activities among government, academia, and industry for the advancement of ocean science, technology and education. The Program is chaired by top-ranking officials from the U.S. Navy, NSF, Department of Energy, U.S. Coast Guard, Defense Advanced Research Projects Agency, NOAA, NASA, EPA, USGS, MMS, and the Office of Management and Budget. NOPP is preparing The Ocean Observations Task Team report: "An Integrated Ocean Observing System: A Strategy for Implementing the First Steps of a U.S. Plan". NOPP has agreed to be a partner with the Alfred P. Sloan Foundation to help implement the Census of Marine Life (CoML) and specific studies that are relevant to the common research interests and goals of the CoML and the U.S. oceanographic agencies.

Interagency Federal Programs

Interagency Arctic Research Policy Committee (IARPC) is the coordinating body for federal agencies charged with implementing Arctic research and monitoring, some of which may occur in the northern Gulf of Alaska. IARPC is chaired and operated by the National Science Foundation (NSF), the lead federal agency responsible for implementing Arctic research policy. The IARPC helps set priorities for future Arctic research, and it works with the State of Alaska and the Arctic Research Commission to develop and establish an integrated national Arctic research policy to guide federal agencies in developing and implementing their research programs in the Arctic.

Marine Protected Areas (MPAs) are an intergovernmental program designed to strengthen the protection of U.S. ocean and coastal resources. The Departments of Commerce and the Interior assisted by other federal agencies are working to strengthen and expand a national system of MPAs by working closely with state, territorial, local, tribal, and other stakeholders. An MPA is defined as, "any area of the marine environment that has been reserved by Federal, State, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein."

National Aeronautics and Space Administration (NASA)

NASA's Earth Science Enterprise remote sensing missions provide a wealth of information that support ocean programs at a fundamental level. Regarding sea level, the TOPEX/Poseidon and Jason-1 altimetry missions will provide high quality sea level estimates for interpretation in climate studies. Sea surface height (SSH) data provide information about the ocean geostrophic flow-field near surface and when assimilated into an ocean circulation model, in the interior ocean as well. SSH data also provide a measure of upper ocean heat and haline variability. NASA and CNES have combined forces to build and operate altimetric missions for obtaining high accuracy SSH data since August 1992. Jason-1 will be the follow-on mission to TOPEX/Poseidon and is slated for launch in May 2000.

Seawinds instruments on the QuikSCAT and ADEOS-II satellites provide estimates of vector wind over the ocean. Wind stress is the primary mechanical forcing function of the ocean circulation. Remote sensing observations of surface winds are the only way to assure a truly global coverage of wind data over the ocean and to assure that meteorological models provide high-quality wind-stress fields. NASA launched its Seawinds scatterometer on the QuikSCAT mission in mid-1999 to provide 25-km resolution of vector surface winds over 90% of the ice-free ocean each day. A second Seawinds instrument is slated for launch in late 2000 on the Japanese ADEOS-2 satellite.

Sea surface temperature is now delivered operationally using a combination of AVHRR data from NOAA satellites and in situ data for calibration. NASA's new technology delivering sea surface temperature includes the MODIS instrument on EOS AM and PM platforms and microwave (all-weather) temperatures from the NASA/NASDA Tropical Rainfall Measurement Mission.

The concentration of chlorophyll in the upper ocean layer can be deduced from relatively small contrasts in ocean color. While absolute calibration of such contrast measurements carried out with different instruments may be a challenge, easily observable fast space-time variations provide valuable insight into the dynamics of primary production and the processes that control it. Such ocean color measurements will be provided more or less systematically by a number of satellite missions and operational programs, including NASA/SeaWiFS, ESA/ENVISAT, NASDA/ADEOS-2, NASA/EOS AM-1 and PM-1, and eventually NPOESS (beginning around 2009).

The Gravity Recovery and Climate Experiment (GRACE) satellite is slated for launch in March 2001. It will provide a high accuracy measurement of the time varying gravity field. Knowledge of the marine geoid is fundamental for using altimeter data to study the absolute ocean currents. This mission also provides information about variable deep ocean currents which is complimentary to that obtained from altimetry.

NASA is currently developing the technology to remotely sense the ocean surface salinity from low earth orbit. The scientific issues are discussed in a report of the Salinity and Sea Ice Working Group.

Sea-ice concentrations (percent aerial coverages) to a resolution on the order of 30km have been obtainable from satellites since the early 1970's using passive microwave radiometer technology. The record from the early and mid 1970's contains many large data gaps, but since Oct. 1978 is reasonably complete in terms of obtaining a consistent global sea ice coverage dataset every 1-3 days. This record demonstrates significant seasonal and interannual variability in the sea-ice cover and its dynamics. This dataset is currently being continued with the DMSP Special Sensor Microwave/Imager (SSM/I) and will be further continued with the Advance Microwave Scanning Radiometer (AMSR) on both the EOS-PM platform and the Japanese ADEOS-II platform, both scheduled for launch in the year 2000.

National Oceanic and Atmospheric Administration (NOAA)

National Marine Fisheries Service (NMFS)

The National Marine Fisheries Service conducts programs that support the domestic and international conservation and management of living marine resources and the fisheries that depend on them. NMFS is organized around Regions that conduct management-operational activities, including some monitoring, and Centers that conduct research in support of regional needs. Centers responsible for Pacific Ocean research and monitoring within NMFS are the Alaska Fisheries Science Center, Northwest Fisheries Science Center Seattle), and the Southwest Fisheries Science Center (LaJolla). The research needs of NMFS in the Alaska Region (Juneau) and the North Pacific Fishery Management Council (Anchorage) are served by the Alaska Fisheries Science Center (AFSC) which includes the Sand Point (Seattle) Headquarters, Auke Bay Laboratory (Juneau), The Kodiak Laboratory, and the Hatfield Marine Science Center (Newport, OR). Major programs include the triennial trawl surveys for groundfish (scheduled to become biennial in 2001), annual longline surveys primarily for sablefish and rockfish, and the Ocean Carrying Capacity program with three cruises a year. Salmon and rockfish genetic stock identification programs are conducted at Auke Bay Laboratory of the Alaska Fisheries Science Center in Juneau, Alaska. Fishing vessel observer programs that collect biological information are conducted out of the AFSC.

National Marine Mammal Laboratory (NMML) is a research organization of the AFSC that conducts research on marine mammals important to the mission of NMFS and NOAA. Geographic focus includes marine mammals off the coasts of Oregon, Washington and Alaska. Activities are information gathering and analysis, including stock assessments, life history determinations, and status and trends. Information is provided to various U.S. governmental and international organizations to assist in developing rational and appropriate management regimes for marine resources under NOAA's jurisdiction. Research programs are carried out cooperatively with other Federal, state and private sector agencies. Marine mammal survey programs include the Cook Inlet marine drift and set gillnet observer program and the Cook Inlet beluga population survey. Offshore killer whale surveys in the NPRB region are conducted by the Southwest Fisheries Science Center as part of a coast-wide program.

NMFS, in conjunction with the states and other federal agencies (USGS and NIST), conducts the National Marine Mammal Health and Stranding Response Program, which collects and analyzes tissue samples from stranded marine mammals for histopathology, contaminants and disease. NMFS also routinely observes fish sampled in resource surveys for the presence of tumors or lesions that may show high levels of contaminants in the environment. Human uses of fisheries are monitored through the Fisheries Statistics and Economics Division, which maintains U.S. commercial and recreational fisheries statistical data, such as pounds and dollar value of commercial landings. In the southeastern U.S. coastal states, NMFS cooperates with the Food and Drug Administration to conduct a Seafood Inspection Program that includes monitoring the level of toxic dinoflagellate, *Pfiesteria piscicida*, and related water quality properties that might pose a threat to human health and the ecosystem.

NMFS partners with other federal and state agencies and academic institutions to support ecosystem programs. Several of the programs collecting ecosystem information including data on physical and chemical oceanography, phytoplankton, zooplankton and forage fishes are: the California Cooperative Fisheries Investigation (CalCoFI) off Southern California; the Marine Monitoring and Assessment Program (MARMAP) in the Northwest Atlantic; SEAMAP in the Southeast U.S.; and the Fisheries Oceanography Coordinated Investigations (FOCI; NOAA's OAR is also a partner) in the Gulf of Alaska and Bering Sea. These programs furnish fundamental information on abundance and distribution of marine fish and invertebrates, and environmental changes which affect them.

Office of Oceanic and Atmospheric Research (OAR)

OAR consists of 12 laboratories nationwide. The office's activities include a complex of geophysical, oceanographic and macrofauna monitoring and evaluation activities that involve NMFS and other NOAA personnel.

Pacific Marine Environmental Laboratory (PMEL) in Seattle focuses on coastal and open ocean observations and modeling to improving understanding of the physical and geochemical processes operating in the world oceans. PMEL's fisheries oceanography program (FOCI), which is a collection of NOAA research programs attempting to understand the influence of environment on the abundance of various commercially valuable fish and shellfish stocks in Alaska waters and their role in the ecosystem, has a project in Shelikof Strait between Kodiak and the Alaska Peninsula. This and other NPRB region monitoring projects are partnered with NMFS' Alaska Fisheries Science Center, under its Resource Assessment and Conservation Engineering (RACE) program. PMEL also conducts retrospective fisheries and oceanographic studies and the rescue and dissemination of older data collected by PMEL scientists. PMEL operates the El Niño-Southern Oscillation (ENSO) Observing System, which supports NOAA's climate prediction mission, primarily on seasonal to interannual time-scales. NOAA's environmental satellite systems, with region and basin-wide observations of sea surface temperature and surface wind speed, are supplemented by the ENSO Observing System. Seventy moorings in the tropical Pacific (called the Tropical Atmosphere-Ocean or TAO array) provide surface atmospheric and ocean mixed-layer observations. Several hundred global Lagrangian drifting buoys in all the major ocean basins; a volunteer observing ships (VOS) expendable bathythermograph (XBT) program of about 40 commercial ships; and a network of tide gauges complete the ENSO system. The resulting data are used to initialize climate models, verify model results, and monitor the evolution of the upper ocean.

Other observing systems maintained by NOAA that are still in the developmental stage, include a shipboard thermosalinograph effort; the Trans-Pacific Profiler Network, consisting of ten profilers in the equatorial Pacific; a Pacific upper-air sounding network on islands and ships in the Pacific; the Pan American Climate Studies Sounding Network of enhanced atmospheric observations; an ocean carbon-ocean tracer hydrographic program to determine global distributions of key chemical, biological, and physical tracers; a submarine cable providing estimates of Florida Current transport; a Voluntary Observing Ship CO2 program of semiautomated systems to monitor CO2; an Atlantic Ocean pilot project (called PIRATA) of 12 buoys in the tropical Atlantic; and an Atlantic profiling float array to study processes important in establishing SST variability.

Another of OAR's 12 labs, the Climate Diagnostics Center, holds the Comprehensive Ocean-Atmosphere Data Set (COADS) with surface marine data since 1854. OAR's Arctic Research Office partners with the University of Alaska Fairbanks to run the Cooperative Institute for Arctic Research (CIFAR) in Fairbanks. Proposals are being solicited in FY 2001 for research on: (1) climate variability and change in the Arctic, and (2) Bering Sea productivity. These funds will be made available from the Department of Commerce/NOAA through the Arctic Research

Initiative, which started in FY 97. NOAA's Office of Ocean Exploration (OE) was founded in 2001 under the Office of Oceanic and Atmospheric Research (OAR) to meet four challenges 1) Mapping at new scales emphasizing regions not previously observed, 2) Exploring ocean dynamics and interactions at new scales, 3) Developing new technologies, and 4) Reaching out in new ways to stakeholders.

National Ocean Service (NOS)

This branch of NOAA is the Nation's principal advocate for coastal and ocean stewardship through partnerships, and supports the science and information needed for the proper balance between environment and economics. In cooperation with the National Science Foundation, NOS supports oceanographic research in the NPRB region, providing about half the support for the Northeast Pacific subprogram of the US GLOBEC. Substantial projects of the GLOBEC program are retrospective analyses and monitoring studies. NOS oversees the newly established Kachemak Bay National Estuarine Research Reserve and its Kachemak Bay Ecological Characterization study. The system of 25 estuarine reserves nationwide monitors physical, chemical and biological parameters in order to depict, track and forecast long-term changes and short-term variability in the resources of these areas. NOS also conducts the National Status and Trends Program which measures levels of toxic contaminants, including trace metals, pesticides, petroleum hydrocarbons, and other toxic organic contaminants and their effects on fish and shellfish. This national program currently includes NPRB region samples in the Mussel Watch contaminants project and formerly included the Benthic Surveillance Project in Alaska. Specimens are held in the Specimen Banking Project at the National Institute of Standards and Technology (see NIST, below).

NOS conducts a number of projects nationally that do not have a presence in Alaska, but may be relevant to Alaska conditions or programs, and could be potential sources of funding for future efforts. One example is NOAA's National Water Level Network along the nation's ocean and Great Lakes shorelines, which includes almost 200 continuously operating water level measurement systems. At five extremely busy harbor entrances, NOS operates Physical Oceanographic Real-Time Systems (PORTS). These systems include acoustic Doppler current profilers with anemometers, packet radio transmission equipment, a data acquisition system and an information dissemination system.

Alliance for Coastal Technologies (ACT) is committed to developing an active partnership with state and regional managers and private industry who deal with the need for effective use of sensor technologies in monitoring coastal environmental natural resources

National Environmental Satellite, Data, and Information Service (NESDIS)

NESDIS holds most of the historical information gathered by NOAA agencies and current satellite, oceanographic, and buoy data, global climatological data, and sea ice information. Much of the information is stored at the National Oceanographic Data Center (NODC), the National Climate Data Center (NCDC), and the National Geophysical Data Center (NGDC). These three data centers cooperate with NASA, the National Weather Service, and many international agencies to provide global information such as sea surface temperature, wind speeds and vectors, biological productivity, salinity, absolute sea height, and other types of observations. NODC is a major partner in the Global Ocean Observing System (GOOS).

NESDIS has a role in ensuring national security, since it serves as the operational and command authority for the Defense Department's Defense Meteorological Satellite Program. NOAA's environmental satellite data are shared in near real-time through an agreement with the Department of Defense in support of the Air Force and the Navy's global and regional weather and ocean forecasting model prediction services. During national emergencies (both military and natural hazards response), NOAA enhances local environmental satellite coverage through its polar orbiting satellites worldwide. For emergencies affecting the western hemisphere, images from NOAA's geostationary satellites are enhanced.

National Weather Service (NWS)

NWS collects weather, hydrologic and climate data for coastal and ocean areas. The National Data Buoy Center has over 100 buoys and several Coastal Marine Automated Network (C-MAN) shore-based stations, some of which are based in Alaska. The center has real-time weather and oceanographic data and cooperates with NODC to provide historical monitoring data.

National Institute of Standards and Technology (NIST)

The NIST cooperates with USGS, NMFS, and NOAA's Office of Protected Resources in maintaining and operating the National Biomonitoring Specimen Bank. Archiving of biological samples for future analysis, and creation and maintenance of databases on specimen samples are NIST specialties.

National Science Foundation (NSF)

The National Science Foundation is a quasi-independent U.S. government agency supporting science and engineering programs worth over $3.3 billion per year. Program areas of potential interest to NPRB are Polar Research, Geosciences, and Biology. NSF also contributes funding for GLOBEC, FOCI and other projects of interest to NPRB.

Technology, instrument development, and infrastructure have been funded by NSF over the last several years. The ALVIN submersible, the best known and one of many ocean observing instruments sponsored by NSF, is continually upgraded to provide state-of-the-art, long times-series, deep ocean observations.

Three observatories: the Hawaii Undersea Geo-Observatory (HUGO)-automated submarine volcano observatory; the Hawaii-2 Observatory (H2O)-broad-band seismometer; and the Long-term Ecosystem Observatory (LEO-15)-broad array of sensing systems are currently involved in technological developments.

A fiber optic cable connecting a series of sea floor nodes capable of supporting real-time transmission of data and images from hundreds of instruments is a design concept being pursued with the National Ocean Partnership Program (NOPP). Another program initiated in 1996 by NSF was Deep Earth Observatories on the Seafloor (DEOS) for observations beyond the reach of fiber optic cables.

A five-year look at the global density and property field of the ocean was obtained from the World Ocean Circulation Experiment (WOCE). Numerous hydrographic sections were repeated during the experiment at regular intervals to address overall structure, meridional overturning, and transport through particularly important "choke points." The Atlantic Climate and

Circulation Experiment (ACCE), a study conducted during WOCE between Greenland and latitudes below the equator using independent subsurface profiling floats, is the model for the Array for Real-time Geostrophic Oceanography (ARGO).

The Argo Ocean Profiling Network is an international effort to collect and share information on the temperature, currents, and salinity of the world's oceans. Such information may be used to improve predictions of weather events such as El Niño and La Niña on our seasonal climate. Each float is programmed to sink a mile into the ocean, drifting at that depth for about 10 days, then slowly rise, measuring temperature and salinity through the layers as it makes its way to the surface. At the surface, data is transmitted to a communications satellite and the probe begins another cycle. Each float is designed to last 4-5 years. Argo floats can be deployed from ships or by aircraft. NOAA and the Office of Naval Research through the National Oceanographic Partnership Program fund the U.S. contribution to ARGO. NOAA, Scripps Institution of Oceanography, University of Washington, and Woods Hole Oceanographic Institution are implementing ARGO. Scientists have determined that 3,000 floats are needed for the full global observing array. The goal is to have the entire array of floats drifting and bobbing throughout the world's ice-free oceans by 2003.

Early in the next decade ARGO will furnish a major portion of the database for the Global Ocean Data Assimilation Experiment (GODAE). The large number of independent floats released under ARGO, supported by NSF, is planned as a part of the long-term climate research program. In addition to ARGO, Global Eulerian Observations (GEO) will provide diagnostic and verification of the Lagrangian measurements, greatly decreasing their uncertainties, and lead to more accurate portrait of global heat fluxes.

In 1977, the Oceanic Flux Program (OFP), the first continuous time-series particle flux in the deep ocean was inaugurated at Hydrostation S. The observation that the particulate flux to depth was not constant but seasonally dependent on the plankton production cycle amazed the oceanographic community.

In 1988, as a part of U.S. JGOFS, several stations in the North Pacific, North Atlantic and near Bermuda, were funded by NSF to collect (oceanic time-series) to provide a greater understanding of the oceans' role in global and climate change. The stations in the North Pacific and near Bermuda have become prototypes for other national and international oceanic time-series observatories.

The principle goal of the Carbon Retention In A Colored Ocean Program (CARIACO), instituted in 1995, was studying the relationship between surface biogeochemical processes and the fluxes of carbon and nutrients in a continental margin setting influenced by seasonal upwelling.

The U.S. GLOBEC Northwest Atlantic-Georges Bank Program is intended to assimilate the population dynamics of major species on the Bank in terms of their relationship to the physical environment, predators and prey. The ultimate goal is to be able to forecast changes in the distribution and abundance of these species as a result of changes in their physical and biotic environment as well as to predict how their populations might respond to climate change. Continuing observations will be essential in the foreseeable future. A similar U.S. GLOBEC

Northeast Pacific Program (NEP) has initiated a study of the effects of past and present climate variability on the population ecology and population dynamics of marine biota and living marine resources.

NSF has funded studies of existing ocean and coastal data sets, including the Continuous Plankton Recorder Surveys and the California Cooperative Fisheries Investigations (CalCoFI). NSF has also helped to sponsor a series of workshops to gather all the historical data surrounding major fish stock explosions and crashes, subjecting them to extensive modeling exercises in an effort to prove or disprove the many speculative hypotheses established to explain them.

For several years studies in the Great Barrier Reef have focused on coral and algae, as have the ecology of reefs in relation to El Niño events in the eastern tropical Pacific, rocky shore sites along Northern Massachusetts and the outer coast of Washington State. These studies were expanded to include Long-Term Ecological Research (LTER) in Land/Ocean Margin Ecosystems. The network includes freshwater and tidal forcings and geomorphology, watershed land-use types, and aquatic and terrestrial biogeographic provinces and climatic regions. These programs have been useful in measuring coastal ecological system responses to ENSO and other long-term climactic variability.

Comprehending the causal linkages and covariations among the physical, chemical, and biological components of mid-ocean ridge volcanic and hydrothermal systems, and the long-term temporal evolution of these systems is an important aspect to a number of on-going and planned programs. Six areas are involved in the programs: three on the Juan de Fuca Ridge in the northeast Pacific Ocean, one on the East Pacific Rise off southern Mexico, one on the East Pacific Rise off northern Peru, and one on the Mid-Atlantic Rise south of the Azores. Through repeat visits, the programs involve long-term temporal observations and could evolve into permanent, real-time observatories in the future.

The Earth's climate system varies on time scales greater than the instrumental record, from the major changes of glacial/interglacial cycles to the recently-identified millennial cycles of the North Atlantic and the decadal oscillations of the North Pacific. Capturing the full natural variability of the system, requires highly-resolved records spanning hundreds or even thousands of years. Preservation of these "paleo" time-series are recorded in oceanic sediments and other geo-archives such as massive corals.

U.S. Arctic Research Commission (USARC)

The U.S. Arctic Research Commission was established by Congress under the Arctic Research and Policy Act of 1984 to promote Arctic research, develop national research plans, and facilitate interagency coordination within the federal government and state and local governments in Arctic research. An important resource for the USARC established by ARPA (P.L. 98-373 [1984]; amended P.L.101-609 [1990]) is the Interagency Arctic Research Policy Committee (IARPC) operated by NSF, described separately in this section. The Commission is composed of seven members appointed by the President plus the director of the National Science Foundation. USARC has produced its set of research priorities for FY 2001 that includes a renewed emphasis on the Bering Sea and a call for increased efforts dealing with climate change in the Arctic. Under the Arctic Council, the U.S. has taken the lead role in the preparation of an Arctic Climate Impact

Assessment (ACIA), to be prepared by experts from all of the arctic countries and other countries with arctic interests.

U.S. Environmental Protection Agency (USEPA)

The mission of the Environmental Protection Agency is to protect human health and to safeguard the air, water, and land of the nation. Of particular interest to the NPRB program is the EPA's Environmental Monitoring and Assessment Program (EMAP), which seeks to fulfill a national mission that may be very similar to some elements of NPRB's regional charge. The purposes of the EMAP program are to provide a comprehensive report card on the status of the ecological resources nationwide and to detect trends in these resources. In addition to having common concerns, the review of the design phase of EMAP by the National Research Council (NRC 1995) is also relevant to NPRB. EMAP is a partnership between EPA and NOAA for long-term, integrated monitoring, research, and assessment to ascertain the status of our nation's ecological resources. EMAP's purpose is to develop the scientific understanding for translating environmental monitoring data from multiple spatial and temporal scales into assessments of ecological condition and forecasts of the future risks to the sustainability of our natural resources. This data supports the National Environmental Monitoring Initiative of the Committee on Environment and Natural Resources. EMAP implements monitoring programs that operate on regional scales, highlighting different ecological resource categories, over periods of several years, including five monitoring activities: (1) completion of the Mid-Atlantic Integrated Assessment Geographic Initiative; (2) initiation of the Western Pilot Geographic Initiative; (3) planning for a National Coastal Survey; (4) developing probabilistic coastal monitoring in all coastal states; and (5) establishment of an interagency (EPA, NOAA and NASA) effort to develop an intensive coastal site network of monitoring and research locations throughout the United States.

EPA also issues National Pollution Discharge Elimination System (NPDES) permits, which typically require that the permittee monitor discharges. Permittees include the Alyeska Marine Terminal in Valdez, seafood processors, hatcheries and logging companies. EPA also maintains a list of hazardous waste handlers under the Resource Conservation and Recovery Act (RCRA) and may require that the handlers monitor certain aspects of their activities. The RCRA list is based on those who report the handling of hazardous wastes through, for example, storage or transport. EPA also monitors Superfund sites.

EPA research laboratories and program offices support several coastal ocean observation studies. Additionally some federal, state and local governments, and private entities' projects fall under EPA's jurisdiction.

EPA maintains observations to ensure compliance with legislative mandates and regulatory requirements. Protection of marine ecosystems from the adverse effects of the disposal of dredged materials and treated wastewater encouraged development of Ocean Dumping and Ocean Discharge Programs. Possible impacts include problems associated with eutrophication, pathogens and toxics that result in adverse effect on human health and biological integrity of the coastal waters, as well as habitat modification and loss. Data includes the quality of dredged materials or treated wastewater, and the physical, chemical, and biological circumstances of the marine environment surrounding the disposal or discharge area.

States are required by the National Water Quality Inventory to report water quality conditions to EPA for inclusion in the National Water Quality Inventory Reports to Congress. The water quality includes physical, chemical, and biological conditions, and is processed according to monitoring results of the water quality of waters, including estuarine and coastal waters.

The National Estuary Program (NEP) was founded by Congress to restore and preserve estuaries; the program currently includes 28 estuaries that represent 42% of the shoreline of the continental U.S. These programs are in various stages of development. Each individual estuary program inventories existing Federal, State, local and volunteer monitoring programs in their area and combines pertinent details from these on-going activities into their own monitoring plans according to EPA guidance. Each NEP is developing its own database management system.

The Chesapeake Bay Program established in 1984 by the Chesapeake Bay Executive Council, is a Bay-wide EPA/state joint effort. The program is made up of over 165 stations below the fall line, and combines the efforts of Maryland, Pennsylvania, Virginia, the District of Columbia, several federal agencies, 10 institutions, and over 30 scientists. Nineteen physical, chemical, and biological characteristics are monitored 20 times a year in the main stem of the bay and its many tributaries. A volunteer citizen monitoring program was started in 1985.

The Great Lakes National Program combines several Federal, state, tribal, local, and industry partners in an integrated, ecosystem approach to protect, maintain, and restore the chemical, biological, and physical integrity of the Great Lakes. The program monitors Lake ecosystem data; manages and provides public access to Great Lakes data; and helps communities address contaminated sediments in their harbors.

The Gulf of Mexico Program is made up of many State and local monitoring projects. An integrated coastal monitoring and assessment program for the Gulf of Mexico is currently being designed, with four main focus areas: excessive nutrient enrichment; public health associated with seafood consumption and recreational use; habitat loss; and non-indigenous species introduction.

The Clean Water Action Plan, a new initiative, is an ambitious multi-agency proposal to speed the restoration of our nation's waterways. One important component is development of a Coastal Research Strategy involving integrated studies of coastal waters and a public report on the condition of the nation's coastal waters in 2000.

U.S. Department of the Interior (USDOI)

Fish and Wildlife Service (USFWS)

The Alaska Maritime National Wildlife Refuge (AMNWR) monitors ten seabird colonies annually, four of which are in the NPRB region. The AMNWR also monitors other sites on a periodic basis largely dependent upon availability of funds.

The Office of Subsistence Management is entering its second year of the Federal Subsistence Fishery Monitoring Program. The program is directly administered by the Fishery Information Services Division, which consists of staff with expertise in both fisheries and social sciences, and funds studies that gather, analyze and report information needed for subsistence fisheries management on federal lands in Alaska. Funded studies focus on three information types:

Traditional Ecological Knowledge, Subsistence Fishery Harvests, and Fishery Stock Status/Trends. Most studies contribute to developing the capabilities and expertise of agencies, local communities and rural residents to participate in subsistence fishery resource management. For purposes of management and research, Alaska federal subsistence fisheries have been grouped into 10 regions. Each region has an Advisory Council consisting of local residents who represent the geographic and cultural diversity of that region. In addition to providing recommendations on policies, Advisory Councils also identify study needs and make recommendations on project proposals for their region.

Minerals Management Service (MMS)

The MMS provides substantial support for projects related to the potential effects of oil and gas exploration and recovery that are largely conducted by other agencies and contractors. Studies envelop a wide range of resources such as sediment quality, seabird monitoring, mapping of riptides, Cook Inlet forage fish and others. MMS has funded a varied range of project types for many years. The University of Alaska Fairbanks and the MMS have joined to form the Alaskan Coastal Marine Institute (CMI). The purpose of the CMI is to provide matching MMS funding for research in Alaska on coastal, marine and human environmental issues pertaining to offshore mineral exploration and extraction. Researchers must secure at least one dollar of non-federal matching funds for every dollar from the CMI. Projects should address the Beaufort Sea and secondarily Cook Inlet/Shelikof Strait.

U.S. Geological Survey (USGS)

The Biological Research Division's (BRD) Alaska Biological Science Center maintains a seabird database and a pelagic seabird atlas. The Alaska Biological Science Center (Biological Resources Division, U.S. Geological Survey) is the lead biological science agency for the Department of the Interior (DOI) in Alaska, where it conducts research on wildlife and their habitats on Federal public lands and waters. Federal public lands in Alaska cover a geographic area equivalent to the all of the Eastern seaboard from Maine through Florida and include nearly all of the country's National Wildlife Refuges (88%) and most of its National Park lands (65%). Clients of ABS include the National Park Service, Fish and Wildlife Service, Bureau of Land Management, and Minerals Management Service. Responsibilities also include providing scientific information essential for resource management decisions for DOI trust species such as migratory birds, marine mammals, and anadromous fish species.

BRD cooperates with many other projects from several agencies to obtain the contents of this database. In addition, since the 1970s BRD has had an extensive seabird-monitoring project at Middleton Island, the Marine Biological Station. BRD also is in the process of assembling the Pacific Seabird Monitoring Database. The Alaska Marine Mammals Tissue Archival Project (AMMTAP) and the Seabird Tissue Archival Monitoring Project (STAMP) are probably the most significant contaminants studies in Alaska.

The Water Resources Division of the USGS in Alaska maintains the Cook Inlet Basin Study Unit, part of the National Water Quality Assessment program (NAWQA), which examines trends in water quality over a nine-year period. Measurements are made to determine water chemistry in streams and aquifers; the quantity of suspended sediment and the quality of bottom sediments in streams; the variety and number of fish, benthic invertebrates and algae in streams; and the presence of contaminants in fish tissues. The Water Resources Division also maintains a long time series of measurements of groundwater and freshwater runoff for various stations in Alaska.

The Geologic Division has the capability to produce high-resolution maps of the sea floor through its Marine and Coastal Geology Program in Menlo Park, California.

U.S. Department of Agriculture (USDA)

U.S. Forest Service (USFS) has substantial responsibility for controlling and directing the impacts of human uses. The USFS conducts occasional surveys of recreational use in PWS. These surveys are not conducted on a regular basis and are therefore not intended to serve as a long-term monitoring instrument. The USFS also reports on use of campgrounds, visitor centers and other facilities operated by the agency in the NPRB region. The Forest Service has extensive experience in watershed analysis and planning for ecosystem-based management. Extensive experience in developing scientific information relevant to balancing multiple uses of public lands and waters is available for planning monitoring and research.

U.S. Department of the Navy (USDN)

Ocean observations collected by the U.S. Navy were originally developed around two objectives due to national security reasons (1) Up-to-date forecasts for open ocean waves, weather and ice flow patterns for the safety of fleet operations, and (2) the Cold War requirement for open-ocean temperature, salinity and sound velocity measurements to support sonar performance in the tracking of Soviet ballistic-missile submarines. The national security-supported ocean observation system has, therefore, included heavy emphasis on open-ocean temperature, salinity, winds and ice observations. Several elements included in that system are: expendable temperature probes, used by navy ships and aircraft to take bathyermograph (XBT) measurements around the globe during fleet operations using probes that measure temperature with water depth as the probe falls through the water column: and satellite temperatures of the sea surface taken by infrared satellite sensors.

National security requires real-time global data and the Navy acts as a national Core Processing Center for sea surface temperature (SST) data from various satellites and disseminates the data to civil and military users worldwide. Other types of satellite measurements are used in remote areas where ship and buoy measurements are not readily available. Satellite altimetry measures the height of the sea surface roughness to infer winds. Products include sea-surface topography, currents, eddies, wave heights, and surface wind-speed and direction.

Drifting buoys are deployed yearly by the Navy with hourly feedback via satellite. They measure surface atmospheric pressure, air and sea surface temperature, winds and wave, and surface currents, that provide excellent "ground-truth" for satellite observations, as well as water temperature with depth, and "ambient" (background) noise levels that support Nave sonar operations.

The National Ice Center receives information from the Navy, NOAA, and the Coast Guard on global, regional, and local sea-ice analyses and forecasts, including ice edge, concentration, drift and thickness, for military and civil users. Ice observations come from U.S. and European satellites, U.S. and Canadian ice reconnaissance flights, and from specially instrumented buoys placed each year through the Arctic ice.

A dedicated fleet of Navy ships has collected the following data for years: water depth, bottom type, tides and currents or "hydrographic" data in coastal areas worldwide to improve and update nautical charts; deepwater bathymetry (water depth) and gravity measurements to support strategic submarine operations; physical oceanography (temperature, salinity, sound velocity), ambient noise, seafloor structure and sediment type to support sonar performance and acoustic surveillance arrays; and a wide range of other observations (water clarity, bioluminesence, currents, magnetics) that affect naval operations.

The Navy's national security needs for ocean data are now focused not only in the open ocean but also increasingly on the coastal waters of the world. They are a significant supporter of a national academic research fleet, funding both worldwide basic ocean observations and applied research projects. Data from the open ocean through coastal waters, the surf zone, and over the beach are all required to sustain modern naval operations. Because of the greater variability, shallow coastal waters require more observations in time and space. Of particular interest are water depth, sea surface temperature and temperature at depth, bottom type, waves, tides, currents, and coastal ambient (or background) noise. While the main national security requirements for coastal ocean observations are in sensitive areas overseas, the diversity of environments in U.S. coastal waters provides many analogues of coastal systems overseas. For this reason, national security needs must play a significant role in design of the coastal observing system. Navy home-porting, and coastal training, test and exercise functions in U.S. waters require expanded observations.

The U.S. Naval Observatory (USNO) is the basic source of information on the effect of astrophysics on climate change. The Earth's orbit, its orientation in space, and its angle of inclination toward the sun, as measured by the USNO, all play important roles in determining climatic conditions. The USNO is the world's leading authority in the areas of measuring day length, celestial observing, and other fundamental astronomy.

U.S. Department of Transportation (USDOT)

U.S. Coast Guard (USCG)-- USCG ocean data buoys take synoptic meteorological and oceanographic measurements for both the National Data Buoy Center and the National Ice Center. They also provide a number of other ocean or lake observations. The USCG operates a Vessel Traffic Service (VTS) for nine United States coastal ports. Each VTS is a service of active waterways management using advanced technology such as radar, closed circuit TV, differential GPS (DGPS), and VHF-FM radio communications. In addition, the VTS also receives information from various sources on predicted vessel movements, hazards to navigation, aids to navigation discrepancies, and other information of interest to VTS users. The VTS involves individuals off the vessel that receive, process, and communicate information related to the safe navigation of a waterway with a primary focus of public safety and protection of the environment. This information is communicated in general public advisories or in the form of specific recommendations to assist a vessel in avoiding hazardous conditions early on. VTS does not usually interfere with the vessel's sailing route.

Sea ice and icebergs are monitored by the International Ice Patrol (IIP), which is supported by 17 member nations and operates in the North Atlantic under the provisions of the U.S. Code and the International Convention for Safety of Life at Sea (SOLAS). It monitors iceberg danger near the Grand Banks of Newfoundland during the ice season, and advises ships of safe and efficient navigation routes. The USCG International Ice Patrol sets drifting buoys for the use of iceberg/sea ice prediction. The observations of position and sea surface temperature are reported via satellite eight times per day. The IIP obtains water temperature profiles from AXBTs deployed by Coast Guard aircraft and sea surface temperature data made available by commercial ships. These data are sent to the Navy. The National Ice Center provides sea-ice analyses and forecasts using data from satellites, aircraft reconnaissance flights, and arctic buoys received from the USCG, NOAA and the Navy. USCG Polar icebreakers provide a number of oceanographic observations in the Arctic and Antarctic to Navy, NIMA, and/or NOAA databases. The reports include ocean temperature, salinity, bathymetry, and marine mammal data.

USCG cutters send weather information to the Navy and NOAA. Coast Guard stations also send meteorological data to NOAA for use in analyses and forecasts.

U.S. Department of Energy (USDOE)

The Department of Energy, Biological and Environmental Research (DOE-BER) is funding peer-reviewed research in marine biology and oceanography relating to the impact of anthropogenic CO2 on global warming. DOE also encourages technological developments that support new global ocean observational capabilities. Examples of specific programs include:

- Marine Biotechnology - the application of the tools of modern molecular biology to linkages of carbon and nitrogen cycles.
- Synthesis of Global CO2 Data (with NOAA) - development of tools and models to synthesize the existing data set on ocean CO2, and related parameters.
- Quality Assurance of CO2 Survey Data - QA/QC and dissemination of CO2 data through the Carbon Dioxide Information Analysis Center.
- Carbon Sequestration in the Ocean - establishment of center(s) of excellence as part of the Climate Change Technology Initiative.

Intergovernmental Organizations

Bristol Bay Marine Mammal Council (BBMMC)/Bristol Bay Native Association (BBNA)

The BBMMC was formed in 1995 by the thirty-one member tribes of the BBNA and works closely with marine mammal organizations to best utilize our resources and avoid redundancy in monitoring efforts.. The larger body is governed by a seven member Executive Council which consists of one representative from each of the five sub-reg8ions of Bristol Bay and two at-large members. The general membership and the Executive Council are a accurate representation of the people from each sub-region. The Executive Council can come together and discuss the marine mammal concerns of each sub-region and look for ways to resolve those concerns. .

The BBMMC recognizes the dynamic nature of the marine ecosystem and the difficulties associated with large scale research efforts. To best use limited funding, the BBMMC supports the expansion of successful programs to the Bristol Bay region that currently exist in other regions of Alaska:

- Harbor seal biosampling program;
- Harbor seal harvest monitoring;
- ArcView mapping of projects; and,
- Consensus building among Bristol Bay area villages.

Pacific Coastal Salmon Recovery Program

The U.S. Congress, recognizing the need to assist states and tribes with Pacific Coastal Salmon Recovery, appropriated funds for the states of Alaska, Washington, Oregon and California, as well as the treaty fishing tribes in the Pacific Northwest.

This is a cooperative program that assists the States in fulfilling responsibilities under the Pacific Salmon Treaty by providing administrative, management, and applied research support to the States treaty Indian tribes to meet the needs of the Pacific Salmon Commission and U.S. international commitments under the treaty.

Since implementation of the Pacific Salmon Treaty in 1985, the States of Washington, Oregon, Idaho, and Alaska have provided the necessary support to and have been involved with the Pacific Salmon Commission in accordance with the treaty. Alaska has provided and continues to provide technical support necessary for supporting and enhancing the U.S. position on Yukon River salmon, Taku and Stakine river salmon and salmon fisheries in ongoing negotiations with Canada. In fiscal year 1999, four awards were made. It is anticipated that eight awards will be made in fiscal years 2000 and 2001. For the Pacific Coast Salmon Recovery Program, it is anticipated that five awards will be made in fiscal years 2000 and 2001.

The State of Alaska intends to apply the salmon funds over a five-year period to address salmon issues in Southeast Alaska, east of Cape Suckling. The general project areas are:

- *Research and Monitoring*: the focus is on important salmon producing streams and systems - uplands through estuaries, wild salmon stocks, transboundary rivers, and identification of habitat stewardship and restoration priorities;
- *Habitat Stewardship and Restoration*: the focus is on on-the-ground fish passage remediation projects on state, local, Native and private lands with initial focus on Coho, Chinook, and sockeye watersheds adversely impacted by human practices, and ensuring important habitat is not degraded;
- *Improve Economics of SEAK Fishing*: the focus is on the broad range of projects to mitigate impacts of Pacific Salmon Treaty on fisherman and fishing communities in SE Alaska; and,
- *Cooperative Programs*: the focus is on cooperative or joint projects with Pacific Northwest tribes, tribal entities, Canada, and/or Pacific Northwest states on salmon habitat or stocks of common concern.

Nongovernmental Organizations

Alaska Beluga Whale Committee (ABWC)

The ABWC was formed in 1988 to promote conservation and management of beluga whales, obtain better harvest information and to provide a means of better communication between beluga hunters, biologists and agencies.

The ABWC brought together representatives from beluga hunting communities in Alaska; local, state and federal governments; and beluga researchers to discuss conservation issues, the biology of belugas, and the needs for additional information. They initiated a program to obtain reliable harvest data, prepare a beluga management plan, and to encourage beluga research.

To date, the ABWC has accomplished the following:

- adopted the Alaska Beluga Whale Management Plan;
- signed a Co-management Agreement for Western Alaska Beluga Whales;
- obtained harvest information from ABWC members since 1988 and supported harvest monitoring and sampling;
- conducted aerial surveys: Norton Sound, Bristol Bay, and the Chukchi Sea;
- funded genetic stock ID study using samples from hunters in which the results support genetic discreteness of five stocks;
- supported contaminant studies of belugas in the eastern Chukchi Sea and Cook Inlet;
- produced newsletters informing coastal residents and others about important beluga research and management activities; and ,
- successfully satellite tagged belugas in the Chukchi Sea in 1998 and 1999 and started a pilot program in Norton Sound.

Alaska Eskimo Whaling Commission (AEWC)

The mission of the AEWC is to provide leadership, guidance and coordination in the administration and implementation of policies and programs established by the AEWC Board of Commissioners, and the successful implementation of the AEWC-NOAA Cooperative Agreement as it relates to the whaling captains and crew members that make up the AEWC in the ten subsistence whaling communities. The AEWC was formed in 1977 to represent the whaling communities in an effort to convince the U.S. Government to take action to preserve the Eskimos subsistence hunt of bowhead whales and its purpose is:

- to preserve and enhance a vital marine resource, the bowhead whale, including protection of its habitat;
- protect Eskimo subsistence bowhead whaling;
- protect and enhance the Eskimo culture, traditions, and activities associated with the Bowhead whales , and subsistence bowhead whaling; and,
- to undertake research and educational activities related to bowhead whales.

The following goals were established to carry out these purposes:

- ensure that the hunt of the bowhead whale is conducted according to the AEWC Management Plan in a traditional, non-wasteful manner;
- promote extensive scientific research on the bowhead whale so as to ensure the continued health of the bowhead whale stock; and,
- communicate to the outside world the facts pertaining to the subsistence bowhead whale hunt, the manner in which it is conducted, the Eskimo's knowledge of the whale, and the centrality of the hunt to the cultural and nutritional needs of the Eskimos.

Aleut Marine Mammal Commission (AMMC)

The Aleut Marine Mammal Commission (Commission) is formed primarily for the following purposes:

- to encourage and implement self-protection and self-regulation of marine mammal use by coastal Alaska natives who utilize this resource by involving Native users in the decision making process;
- to provide education and information to the public, appropriate management agencies and other interested parties;
- to represent its member coastal Alaska native communities in reviewing and commenting on regulatory changes or resource development which may effect marine mammals;
- to promote conservation of marine mammals for use by Alaska Natives;
- to be involved in all phases of scientific, biological and other research programs involving marine mammals;
- to actively participate in the formulation of, and/or implementation of harvest monitoring efforts and protection of the marine mammal population; and,
- to encourage the Aleut Marine Mammal Commission, government of the United States, and other nations and indigenous groups to cooperate in exchanging information that contributes toward improved management of marine mammal populations.

Currently, the Commission includes representatives from the communities of Nikolski, Atka, Unalaska, Akutan, False Pass, Nelson Lagoon, King Cove, Sand Point, and Cold Bay. The Commission gathers and disseminates local knowledge regarding the Steller sea lion and other marine mammals in the Aleutian Islands and along the Alaska Peninsula. Information will include but is not limited to:

- the current level of subsistence take in these communities;
- historical perspectives on subsistence harvests;
- changes in mammal populations and local marine environments; and,
- information on the historical and current distribution of marine mammals.

The goal of the Commission is to provide information on subsistence harvest, particularly Steller sea lions, which will assist state and federal agencies in the management and conservation of the species.

Alaska Native Harbor Seal Commission (ANHSC)

The ANHSC is a tribal consortium organized by Native Communities within the range of the harbor seal founded with support from the Exxon Valdez Oil Spill Trustee Council, the National Marine Fisheries Service, and other sources. The ANHSC region extends along the Pacific coast form southeast Alaska to the western tip of the Aleutian Island Chain. The region encompasses six coastal areas represented by six ANCSA regional corporations including Southeast Alaska, Cook Inlet, Chugach, Kodiak, Bristol Bay and Aleut.. The overall purpose of the ANHSC is to strengthen and increase the role of Alaska Natives in resource policy decisions affecting harbor seals and to maintain their cultural uses. The goals of the ANHSC include:

- educating and informing the public and western scientists on the traditional and contemporary relationship between harbor seals and Alaska Natives;
- informing western scientists about the type and extent of knowledge held by the local people about the harbor seal;
- involving Alaska Natives directly in harbor seal research; and,
- involving Alaska Natives in the management of harbor seals through Co-management as provided for in Section 119 of the Marine Mammal Protection Act.

In April of 1999 ANHSC and NMFS finalized and signed a co-management agreement for Harbor seals in Alaska that delineates shared roles and responsibilities of each of the parties in harbor seal management. The goal and primary objective for the ANHSC continues to be to develop a solid working relationship between the Federal government and the Tribal Governments as represented by the ANHSC. The co-management committee is comprised of 3 Alaska Natives, and 3 NMFS people has been established. Staff will:

- work with involved villages to implement the guidelines of the agreement through village codes and ordinances;
- be responsible for the complimentary programs such as outreach and education; and,
- act as a liaison between villages, the plannerrs and the federal agencies through the co-management process.

Alaska Sea Life Center (ASLC)

ASLC is located in Seward is a regional center for research on marine life, including mammals, sea birds, and fish. University and government scientists who need to learn how to care for marine resources use the laboratories, salt-water tanks, and marine aviaries of the Center. It is an important a regional research center for studies of the Steller sea lion The ASLC is open to the public and it offers its facilities and staff for educational purposes of the community and state.

Anchorage Waterway Council (AWC)

AWC is a nonprofit organization whose membership resides in the Municipality of Anchorage and believes that Anchorage's waterways and related habitats are a valuable resource. AWC focuses on waterways within the Municipality of Anchorage and intends to prohibit further degradation. They seek to enhance the waterways through public outreach and education, ensuring safe and productive aquatic and riparian habitat for fish, wildlife, and monitoring activities that affect the Municipality's waterways.

Census of Marine Life (CoML)

CoML is being developed as a decade-long program to promote and fund research assessing and explaining the diversity, distribution, and abundance of species in the world oceans. Related activities integral to this research include the design and implementation of innovative biological sampling techniques for the marine environment. Consultations and workshops during 1997-1998, largely funded by the Alfred P. Sloan Foundation (New York City), explored the potential benefits, issues (technical, scientific, and social), and limits of a marine Census. A broad set of precepts for the Census of Marine Life has been prepared. An international Steering Committee fosters development of coherent goals and a scientific plan for the CoML. Planning and development for the Census is expected to require 1-2 more years. Pilot field projects should take place in 2002-2004. The main field projects should occur in 2005-2008. Analysis and integration of information should culminate in 2008-2010. The Ocean Biogeographical Information System OBIS is envisioned to be a distributed network of marine biological and environmental data for use in examining the changes in diversity, distribution, and abundance of organisms over time and space. OBIS is expected to be the means by which CoML gathers and distributes its information.

Center for Alaskan Coastal Studies (CACS)

CACS is a nonprofit group whose mission includes the generation of knowledge of the marine and coastal ecosystems of Kachemak Bay through environmental education and research programs. The Center supports a Coast Walk program for Kachemak Bay annually for citizen collection of data about intertidal areas and incorporates water quality and intertidal monitoring into school education programs.

Consortium for Oceanographic Research and Education (CORE)

CORE promotes, encourages, develops, and supports efforts to advance knowledge and learning in the science of oceanography and to disseminate such knowledge to the scientific community and to the public. It serves as a coordinating body for more than 50 marine-related institutions in the United States, including universities, governmental laboratories, and non-profit aquaria. CORE is the base for the International Steering Committee for the Census of Marine Life and the Secretariat, which the Steering Committee guides. CORE also acts as the Program Office for the National Oceanographic Partnership program, NOPP.

Cook Inlet Keeper (CIK)

CIK is a nonprofit group dedicated to protecting Cook Inlet's watershed. The Lower Kenai Peninsula Watershed Health Project monitors four high value salmon streams with increasing human use. This group also trains volunteers to monitor water quality at many sites in the Cook Inlet watershed. Currently, monitoring sites are established around Kenai, Homer and Anchor

Point. Parameters measured are temperature, pH, dissolved oxygen, salinity, turbidity, conductance, bacteria, oxidation-reduction potential, macroinvertebrates, ortho-phosphate, apparent color and nitrate-nitrogen.

Kenai River Sportfishing Association (KRSA)

KRSA is a nonprofit organization that provides financial support for riparian zone habitat conservation and rehabilitation. KRSA works in cooperation with other organizations, such as state and federal land and fisheries management agencies, and volunteers to stabilize and revegetate banks eroded by human recreational use and housing development. KRSA has also been instrumental in widespread installation of riverfront walkways on public and private property. The walkways are constructed of open metal bar screen that allows riparian plants to grow for bank stabilization, while preventing erosion from trampling by humans and providing access for recreation.

Monterey Bay Aquarium Research Institute (MBARI)

MBARI is a private, non-profit research center funded by The David and Lucile Packard Foundation. It is located at Moss Landing, California, founded in 1987. In the words of its founder, David Packard, "The mission of MBARI is to achieve and maintain a position as a world center for advanced research and education in ocean science and technology, ..." MBARI's efforts cover eight research themes; 1) benthic processes, 2) midwater research, 3) upper ocean biogeochemistry, 4) MBARI Ocean Observing System (MOOS), 5) remotely operated vehicle enhancements and upgrades, new insitu instruments, infrastructure support, and information dissemination and outreach. It has two research ships, and it develops remotely operated vehicles nearby Monterey Bay. MBARI maintains offshore moorings that are equipped with ocean-monitoring instruments. Two MBARI moorings in the equatorial Pacific are part of the NOAA Tropical Atmosphere Ocean (TAO) array that plays an important role in studying the development of events in the El Nino southern Oscillation.

National Outdoor Leadership School (NOLS)

NOLS was founded in 1965 and is the leader in wilderness education. NOLS is the largest backcountry permit holder in the United States and offers courses on four other continents. NOLS is committed to the quality of courses and programs offered in the wilderness environment that serves as its classroom.

North Pacific Universities Marine Mammal Research Consortium (MMRC)

MMRC was formed with four participating institutions: the University of Alaska, the University of British Columbia, the University of Washington, and Oregon State University. The mission of the Consortium is to undertake a long-term program of research on the relation between fisheries and marine mammals in the North Pacific Ocean and Eastern Bering Sea. Studies will focus initially on the biology of the Steller sea lion and could include research on the effects of species interactions and oceanographic conditions on changes in sea lion abundance.

Partners in Science Program

M.J. Murdock Charitable Trust, Partners in Science Program sponsors high school science teachers participation in research with scientists during two summers.

Partnership for the Interdisciplinary Study of Coastal Oceans (PISCO)

PISCO is a long-term ecological consortium that consists of four universities (Oregon State University, UC Santa Cruz, Stanford University, and UC Santa Barbara) investigating the physical and biological processes of the nearshore region along the Oregon and California coasts. The David and Lucile Packard Foundation originally funded PISCO to provide a new model for solving environmental problems faced by our seas.

Prince William Sound Aquaculture Corporation (PWSAC)

PWSAC is a private non-profit corporation founded in 1974 under state law designed to promote development and operation of salmon hatcheries with the participation of local commercial harvesters. Headquartered in Cordova, PWSAC operates four salmon hatcheries at sites throughout Prince William Sound, as well as one at the town of Paxson on the Copper River. PWSAC produces pink salmon, sockeye salmon, Coho salmon and Chinook salmon. The returning adults benefit commercial, sport fishing, personal use, and subsistence users, and also provide cost recovery to fund hatchery operations.

Using technology developed and implemented with the support of the Exxon Valdez Oil Spill Trustee Council, PWSAC annually marks all of the more than 500 million juvenile pink salmon released from its hatcheries each year. The marks permit precise estimation of the proportion of hatchery salmon harvested, which permits protection of wild salmon during hatchery harvests. The marks also permit highly precise estimates of marine survival, and detection of pink salmon of PWS origin in samples on the high seas.

Prince William Sound Oil Spill Recovery Institute (OSRI)

OSRI was authorized by the United States Congress through Section 5001 of the Oil Pollution Act of 1990 (OPA 90) and through amendments included in the Coast Guard Authorization Act of 1996. The institutional goals of OSRI recognize long-range monitoring programs as essential to assess and understand the long-range effects of Arctic or subarctic oil spills on the natural resources of Prince William Sound and its adjacent waters.

Prince William Sound Science Center (PWSSC)

PWSSC is an independent, non-profit organization devoted to implementing an ecosystem approach to research, monitoring and management of natural resources. The Science Center played an important role in implementation of the Trustee Council's ecosystem study, the Sound Ecosystem Assessment (SEA) (Section IV. A. 2.).

Regional Citizens Advisory Council (RCAC)

RCAC bodies were established following the 1989 Exxon Valdez oil spill under the federal Oil Pollution Act of 1990 (OPA 90). The act established, among other things, demonstration programs to involve local citizens in overseeing the environmental impact of oil terminals and tanker operations in two locations, Cook Inlet and PWS.

Cook Inlet Regional Citizens Advisory Council (CIRCAC) monitors the environmental impacts of terminals and tankers in Cook Inlet. The CIRCAC's environmental monitoring program includes studies of sediment chemistry, hydrocarbon accumulation, sediment toxicity and ballast water issues.

The PWS Regional Citizens Advisory Council (PWSRCAC) has conducted an environmental monitoring program for the past six years. The Long-Term Environmental Monitoring Project monitors nine sites in PWS and the NPRB region for hydrocarbons in the water, sediment and mussels. The data provide a benchmark for assessing the impacts of oil transportation and future oil spills. The study discriminates among hydrocarbons resulting from biological processes, combustion sources (pyrogenic) and petroleum products or residues from natural coal deposits (petrogenic). The PWSRCAC has also studied the risk of invasion by non-indigenous species through the discharge of ballast water, control of tanker loading vapors, ballast water influent at the Valdez Marine Terminal, and the use of caged mussels to monitor effluent from the Alyeska Ballast Water Treatment Facility.

Transboundary Organizations

Transboundary organizations coordinate information-gathering across national, provincial and state boundaries. As a result of transboundary conventions addressing fishery management, pollution control, and other matters of concern in the North Pacific, multinational and interstate management institutions have been in place for most of the twentieth century. These institutions have amassed some of the longest time series of biological observations in the North Pacific.

Arctic Monitoring and Assessment Programme (AMAP)

The Arctic Monitoring and Assessment Programme (AMAP) is an international circumpolar program which seeks to monitor anthropogenic pollutants in all parts of the arctic environment. Observations extend into the Bering Sea. At a meeting in Rovaniemi, Finland the nations of Canada, Denmark/Greenland, Iceland, Norway, Sweden, the Soviet Union, and the United States entered into the "Rovaniemi process" to promote arctic environmental protection. The "Rovaniemi process" produced a series of "State of the Arctic Environment" reports on potential pollutants in different parts of the arctic environment and its ecosystems in 1991. The First Arctic Ministerial Conference in Rovaniemi, Finland established international cooperation for the protection of the arctic, and led to the adoption of the Arctic Environmental Protection Strategy (AEPS). The AMAP reports contain time series data on contaminants in the areas of interest. The policy body for AMAP is the Arctic Council.

Conservation of Antarctic Marine Living Resources (CCAMLR)

The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) was founded in 1982 as part of the Antarctic Treaty System, in response to concerns that an increase in krill catches in the Southern Ocean could have a serious effect on populations of krill and other marine life, particularly on birds, seals and fish which mainly depend on krill for food.

The CCAMLR Ecosystem Monitoring Program (CEMP) is a scientific program intended to identify changes in condition, abundance and distribution of the animals within the convention area. Since it is not realistic to monitor all the animals and their interactions that make up the Antarctic marine ecosystem, species and parameters likely to be particularly sensitive to changes in food availability have been identified. Information obtained from monitoring these species is taken into account in determining the regulation of human activity so as to ensure that the conservation principles of the convention are being applied.

The parameters being studied fall into four categories: reproduction, growth and condition, feeding ecology and behavior, and abundance and distribution. Any changes found in the parameters will be because of changes either in food availability or environmental conditions. In order to identify the source of change, it is necessary to monitor krill abundance and distribution, and certain environmental parameters simultaneously with the monitoring of predators.

International North Pacific Fisheries Commission (INPFC-NPAFC)

The International North Pacific Fisheries Commission (INPFC) (1952-1993, U.S., Canada, Japan) and its successor, the North Pacific Anadromous Fish Commission (NPAFC) (1993 on), coordinate research and harvest of salmon and other anadromous species above latitude 33o N outside the 200-mile zones of the signatories. Signatory nations are the United States, Canada, Japan and Russia and the cooperating nations are Poland, South Korea, and Taiwan. The INPFC published long time series of catches for principal groundfish species, crab, shrimp and herring for the signatories and cooperating nations. The INPFC statistical yearbooks (produced from 1952-1992) contain biological time series on groundfish, crabs, and marine mammals. The NPAFC statistical yearbooks (produced from 1993-1995) are the definitive source for catch, weight and hatchery releases for salmon in the North Pacific, as well as principal groundfish species, crab, shrimp, and herring.

International Pacific Salmon Fishing Commission (IPSFC-PSC)

The International Pacific Salmon Fishing Commission (IPSFC) (1937-1985) was established by the United States and Canada in 1937 to restore the sockeye salmon of Canada's Fraser River and to allocate the catches between nations. The IPSFC and its successor, the Pacific Salmon Commission (PSC), have compiled a very long time series of annual Fraser River salmon production, augmented by substantial time series of estimated sockeye salmon productivity by year of spawning. The Pacific Salmon Commission was established by the Pacific Salmon Treaty (PST) between the United States and Canada in 1986. The PSC also has time series of annual harvest and exploitation rates for selected chinook salmon populations, as well as catch and other time series data for all salmon species.

Northern Fund - Pacific Coastal Salmon Recovery Program (PSC)

The Northern Boundary and Transboundary Rivers Restoration and Enhancement Fund was established by Canada and the United States under the revised 1999 annexes to the Pacific Salmon Treaty. The Northern Fund shall be used to support the following activities:

- development of improved information for resource management, including better stock assessment, data acquisition, and improved scientific understanding of factors affecting salmon production in the freshwater and marine environments;
- rehabilitation and restoration of habitat, and improvement of natural habitat to enhance productivity and protection of Pacific salmon; and
- enhancement of wild stock production through low technology techniques rather than through large facilities with high operating costs.

The Northern Fund Committee (• the Committee•) is responsible for approving expenditures from the fund. The Committee consists of three U.S. and three Canadian representatives.

The Pacific Salmon Treaty's Fisheries Management and Stock Assessment are broken down into different annexes that are listed with their objectives in the sections below.

PST Transboundary Rivers Annex:

- manage the district 106, 108 and 111 commercial net fisheries in such a manner as to abide by Treaty harvest sharing arrangements;
- provide estimates of the stock composition of the sockeye salmon harvested in Subdistricts 106-41, 106-30, District 108 and District 111 gillnet fisheries for each week of the fishing season;
- estimate the number of Transboundary Stikine River sockeye harvested in Subdistricts 106-41, 106-30, District 108 and Transboundary Taku River sockeye harvested in District 111;
- collect otoliths from sockeye salmon harvested in District 108 and 111 fisheries to allow estimation of the contribution of enhancement projects to the harvest;
- estimate the escapement of sockey salmon in the Taku River on an inseason basis using mark-recapture methods;
- document the stock timing of the sockeye salmon escapements to the Taku River drainage;
- collect scale samples and associated biological data from sockeye salmon returning to the Taku River through the period of escapement for stock identification and age composition purposes;
- collect scale samples and associated biological data from sockeye slamon returning to Crescent and Speel Lakes for stock identification and age composition purposes;
- statistically reconstruct the Taku River sockeye run; and,
- represent the department of the bilateral Transboundary Technical Committee and at the Pacific Salmon Commission (PSC) meetings and prepare reports and other documents needed for accomplishing our PSC assignments.

PST Northern Boundary Annex:

- Manage District 104 purse seine fishery, prior to Statistical Week 31, for an annual harvest of 2.45 percent of the AAH of Nass and Skeena sockeye salmon in a manner consistent with arrangements negotiated under the Pacific Salmon Treaty;
- manage the Tree Point (District 101) gillnet fishery for an annual harvest of 13.8 percent of the AAH and Nass sockeye salmon in a manner consistent with arrangements negotiated under the Pacific Salmon Treaty;
- manage the Southeast Alaska troll fishery for coho salmon in a manner consistent with specific conservation provisions detailed in the June 30, 1999 revision of the Pacific Salmon Treaty and as stipulated by the Alaska Board of Fisheries;

- estimate inseason, chinook salmon harvest rates in the gillnet and purse seine fisheries so as to remain within the chinook salmon quota level for net fisheries;
- estimate the stock composition of sockeye salmon in major boundary net fisheries (District 101 purse seine and gillnet and District 104 purse seine) to nation and/or system of origin. Commercial catches and escapements on the Boundary Area need to be representatively sampled for sex, length, and scale data;
- estimate the sockeye spawning escapements to Hugh Smith and McDonald Lakes in the southern Southeast Alaska. Collect run timing information and scale and biological samples from these escapements;
- index the escapement of pick and chum salmon to selected streams in southern Southeast Alaska. Estimate observer specific counting rates and conversions between survey counts and actual escapements in these study streams;
- obtain peak survey counts of coho salmon escapements to 15 streams in southern Southeast Alaska that represent a constant proportion to the total escapement to those systems when compared across years;
- estimate the escapement, harvests, and age composition of coho salmon returning to Hugh Smith Lake; and,
- represent the department on the bilateral PSC Northern Boundary Technical Committee and at PSC meetings and prepare reports and other documents needed for accomplishing our PSC assignments.

PST Chinook Annex:

- manage the Southeast Alaska troll fishery for chinook salmon in a manner consistent with the new aggregate abundance-based management regime detailed in the June 30, 1999 revision of the Pacific Salmon Treaty and as stipulated by the Alaska Board of Fisheries;
- estimate migratory patterns, harvests, catch rates, and exploitation rates of various chinook stocks, and determine contributions of wild and hatchery stocks to commercial and recreational fisheries in Southeast Alaska;
- evaluate chinook salmon escapement goals in Alaskan and transboundary rivers and determine what information is needed to improve these estimates; and,
- represent the department at PSC meetings and prepare reports and other documents needed for accomplishing our PSC assignments. Participate in PSC technical committee activities relating to design and use of CWT statistics, abundance-based management of coastwide chinook salmon, and development and testing of the PSC chinook model.

North Pacific Marine Science Organization (PICES)

The umbrella transboundary organization for the North Pacific, the North Pacific Marine Science Organization (PICES), was established in 1992 among Canada, People's Republic of China, Japan, Republic of Korea, Russian Federation, and the United States. PICES coordinates North Pacific (above 30o N) marine information and research on topics such as the ocean environment, global weather and climate change, living resources and their ecosystems, and the impacts of human activities. In order to facilitate the exchange of information, the PICES Technical Committee on Data Exchange has links to long time series on biological, physical, and chemical oceanography, fisheries, and meteorology and marine science organizations. The long time series data set is a compilation of voluntary submissions from data sources and is therefore not exhaustive.

The International Pacific Halibut Commission (IPHC) was the first multinational fishery management organization in the North Pacific, established by the United States and Canada in 1923. The IPHC annual survey provides a long time series of standardized catch of Pacific halibut and associated species. The IPHC time series of research vessel surveys starts in 1925. It is a particularly valuable record of organisms associated with the benthos because of the scrutiny it has received as the basis for many peer reviewed publications over the years.

Pacific States Marine Fisheries Commission (PSMFC)

The Pacific States Marine Fisheries Commission (PSMFC) is an interstate organization created by the U.S. Congress in 1947 to coordinate fisheries issues among California, Oregon, Washington, Idaho, and Alaska. The PSMFC Regional Mark Processing Center is the keeper of the salmon coded wire tag data base, an authoritative source for time series observations on distribution of ocean catches from California to Alaska, including Canada, since 1972.

Global Climate Change Research

The United States is participating as part of a world-wide network dedicated to measuring and understanding global climate change. Global change research programs are valued in the billions of dollars, with state, national and international partners and cooperators. Four international oceanographic investigations on global climate change have elements relevant to the North Pacific. Global Ocean Ecosystems Dynamics (GLOBEC), World Ocean Circulation Experiment (WOCE), Joint Global Ocean Flux Study (JGOFS), and Global Ocean Observing System (GOOS) each rely on the personnel, facilities and finances of the nations and organizations that participate in the transboundary organizations described above.

GLOBEC

GLOBEC is the global change program of the International Geosphere-Biosphere Programme (IGBP) of the International Council for Science. The IGBP provides an international, interdisciplinary framework for the conduct of global change science. GLOBEC is an oceanography program that is examining a number of hypotheses that include a commercially harvested fish species, pink salmon. A key GLOBEC hypothesis is that rapid growth and high survival of pink salmon depend on cross-shelf import of large zooplankton from offshore to nearshore waters. GLOBEC is also collecting data on zooplankton species, including a copepod and several krill species. Physical processes to be examined include stratification, cross-shelf-transport, downwelling and mesoscale circulation in the NPRB region. Another part of IGBP is the Joint Global Ocean Flux Study (JGOFS), which is studying the role of the ocean in controlling climate change through the storage and transport of heat.

GOOS

The GOOS, organized by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational Social and Cultural Organization (UNESCO), is to be a permanent global system for collecting data, modeling and analyzing marine and ocean processes worldwide. Another IOC-sponsored program is the World Ocean Circulation Experiment (WOCE) under the auspices of the World Meteorological Association. WOCE sponsors a large number of investigations directed at understanding the movement of water masses in the world's oceans, including the Pacific and North Pacific.

APPENDIX E. ACRONYMS AND WEB LINKS

ABC: Acceptable Biological Catch
ABWC: Alaska Beluga Whale Committee
ABSC (USGS): Alaska Biological Science Center (Biological Resources Division, U.S. Geological Survey)
http://www.absc.usgs.gov/research/seabird&foragefish/index.html
AC: Alaska Current
ACC: Alaska Coastal Current
ACCE: Atlantic Climate and Circulation Experiment
ACIA: Arctic Climate Impact Assessment
http://www.acia.uaf.edu
http://www.iarc.uaf.edu/structure_of_IARC.html
ADCED: Alaska Department of Community and Economic Development
ACDP: Acoustic Doppler Current Profilers
ACT: Alliance for Coastal Technologies
AEWC: Alaska Eskimo Whaling Commission
ADEC: Alaska Department of Environmental Conservation
ADFG: Alaska Department of Fish and Game
Division of Commercial Fisheries: http://www.cf.adfg.state.ak.us/cf_home.htm
Division of Habitat: http://www.state.ak.us/adfg/habitat/hab_home.htm
Division of Subsistence:
http://www.state.ak.us/local/akpages/FISH.GAME/subsist/subhome.htm
Division of Subsistence Whiskers Database
http://www.state.ak.us/local/akpages/FISH.GAME/subsist/subhome.htm
Division of Sport Fish:
http://www.state.ak.us/local/akpages/FISH.GAME/sportf/sf_home.htm
ADHSS: Alaska Department of Health & Social Services
ADNR: Alaska Department of Natural Resources http://www.dnr.state.ak.us/
Division of Parks and Outdoor Recreation: http://www.dnr.state.ak.us/parks
Division of Mining, Land and Water http://www.dnr.state.ak.us/mlw
ADEOS-II: Advanced Earth Observing Satellite-II
ADOT: Alaska Department of Transportation
AEPS: Arctic Environmental Protection Strategy
http://arcticcircle.uconn.edu/NatResources/aeps.html
AFSC: Alaska Fisheries Science Center (NOAA/NMFS)
http://www.afsc.noaa.gov/generalinfo.htm
AIS: Archival Information System
AMAP: Arctic Monitoring and Assessment Programme
http://www.amap.no
AMHS: Alaska Marine Highway System
AMMC : Aleut Marine Mammal Commission
AMMTAP: Alaska Marine Mammals Tissue Archival Project

AMNWR: Alaska Maritime National Wildlife Refuge
AMOS: Advanced Modelling and Observing System
AMSR: Advance Microwave Scanning Radiometer
ANHSC: Alaska Native Harbor Seal Commission
APEX: Alaska Predator Ecosystem Experiment
ARC: Atlantic Reference Center
ARCUS: Arctic Research Consortium of the United States
http://www.arcus.org
ARGO: Array for Real-time Geostrophic Oceanography
ARGO OPN: ARGO Ocean Profiling Network
http://www.argo.ucsd.edu
ARIES: Australian Resource Information and Environment Satellite
ARLIS: Alaska Resources Library and Information Service
ARMRB: Alaska Regional Marine Research Board
ARMRP: Alaska Regional Marine Research Plan
ARPA: Arctic Research and Policy Act (1984)
ASLC: Alaska SeaLife Center
http://www.alaskasealife.org/
ASP: Amnesiac Shellfish Poisoning
ASTF: Alaska Science and Technology Foundation
http://www.astf.org
ATV: All Terrain Vehicle
AUV: Autonomous Underwater Vehicle
AVHRR: Advanced Very High Resolution Radiometer
AVSP: Alaska Visitor Statistics Program
AWC: Anchorage Waterway Council
http://www.anchwaterwayscouncil.org
AWQ: Division of Air and Water Quality, ADEC
BAHC: Biospheric Aspects of the Hydrological Cycle (IGBP)
BBMMC: Bristol Bay Marine Mammal Council
BBNA: Bristol Bay Native Association
BASS Task Team: Basin Scale Studies Task Team (PICES)
BCIS: Biodiversity Conservation Information System
BDY: Beach Dynamics
BIO: Biological Oceanography Committee (PICES)
BOOS: Baltic Operational Oceanographic System
BRD: Biological Resources Division
CAAB: Codes for Australian Aquatic Biota
CACGP: Commission on Atmospheric Chemistry and Global Pollution
CalCOFI: California Co-operative Fisheries Investigation program
CAOS: Co-ordinated Adriatic Observing System
CARIACO: Carbon Retention in a Colored Ocean Program
CARICOMP: Caribbean Coastal Marine Productivity
CBMP: Chesapeake Bay Monitoring Program

CCAMLR: Commission for the Conservation of Antarctic Marine Living Resources
http://www.ccamlr.org
CCC: Cod and Climate Change (ICES/GLOBEC)
CCCC: Climate Change and Carrying Capacity (PICES/GLOBEC)
CCF: One hundred cubic feet
CDFO: Canadian Department of Fisheries and Oceans
CDOM: Coloured Dissolved Organic Matter
CDQ: Community Development Quota
CEMP: CCAMLR Ecosystem Monitoring Program
http://www.ccamlr.org/English/e_scientific_committee/e_ecosystem_monitoring/e_ecosys_monitoring_intro.htm
CENR: Committee on Environment and Natural Resources
CEOS: Committee on Earth Observation Satellites
C-GOOS: Coastal Panel of GOOS
CHL: Chlorophyll
CHM: Clearing-House Mechanism of the Convention on Biological Diversity
CIFAR: Cooperative Institute for Arctic Research
http://www.cifar.uaf.edu
http://www.cifar.uaf.edu/fisheries.html
CIIMMS: Cook Inlet Information Management and Monitoring System
http://www.dnr.state.ak.us/ssd/ciimms/ciimms_sum2.html
CIK: Cook Inlet Keepers
CIMI: Computer Interchange of Museum Information
CIRCAC: Cook Inlet Regional Citizens Advisory Council
CISNet: Coastal Intensive Site Network
CLIC: Climate and Cryosphere
CLEMAN: Check List of European Marine Mollusca
CLIVAR: Climate Variability and Predictability Program
C-MAN: Coastal Marine Automated Network
CMED/GMNET: Consortium for Marine and Estuarine Disease/Gulf of Mexico Network
CMI (MMS): Coastal Marine Institute
CMM: Commission for Marine Meteorology (of WMO)
CNES: Centre National d'Etudes Spatiales (France)
COADS: Comprehensive Ocean-Atmosphere Data Set
http://www.cdc.noaa.gov/coads
CODAR: Coastal Radar
COLORS: COastal region LOng-term measurements for colour Remote Sensing development and validation
COMBINE: COoperative Monitoring in the Baltic Marine Environment
CoML: Census of Marine Life
http://core.ssc.erc.msstate.edu/censhome.html
CONNS: Coastal Observing Network for the Near Shore
COOP: Coastal Ocean Observation Panel
CoOP (NSF): Coastal Ocean Processes
COP: Coastal Ocean Program

CORE: Consortium for Oceanographic Research and Education
http://core.ssc.erc.msstate.edu/corehmpg1.html
COSESPO: Coastal Observing System for the Eastern South Pacific Ocean
CPR: Advisory Panel on Continuous Plankton Recorder Survey in the North Pacific (PICES)
CPTEC: Center for Weather Forecasts and Climate Studies (Brasil)
CRIS: Court Registry Investment System
CRP: Comprehensive Rationalization Program
CSCOR: Center for Sponsored Coastal Ocean Research
CSIRO: Commonwealth Scientific and Industrial Research Organization
CTD: Conductivity temperature versus depth
CTW: Coastal Trapped Waves
CVOA: Catcher Vessel Operational Area
CZCS: Coastal Zone Colour Scanner
DARPA: Defense Advanced Research Projects Agency
DBCP: Data Buoy Cooperation Panel
DDE: Dichlorodiphenyldichloroethylene
DDT: Dichlorodiphenyltrichloroethane
DEOS: Deep Earth Observatories on the Seafloor
DFO: Department of Fisheries and Oceans, Canada
DMS: Dimethylsulphide
DNMI: Norwegian Meteorological Institute (Det norske meteorologiske institutt)
DO: Dissolved Oxygen
DOC: U.S. Department of Commerce
DoD: U.S. Department of Defense
DODS: Distributed Oceanographic Data System
http://rs.gso.uri.edu/DODS/home/home.html
DOE: U.S. Department of Energy
DOI: U.S. Department of the Interior
DON QUIJOTE: Data Observing Network for the QuIHOTe
EA/RIR: Environmental Assessment/Regulatory Impact Review
EASy: Environmental Analysis System
EC: European Community
ECDIS: Electronic Chart and Display Information Systems
EC/IP: Executive Committee / Implementation Panel for CCCC (PICES)
ECMWF: European Center for Medium Range Weather Forecasting
ECOHAB (NSF): Ecology of Harmful Algal Blooms
EDY: Estuarine Dynamics
EEZ: Exclusive Economic Zone
EEZ(A): European Economic Zone (Area)
EFH: Essential Fish Habitat
EGB (NSF): Environmental Geochemistry and Biogeochemistry
EIOA: European Oceanographic Industry Association
ELOISE: European Land-Ocean Interaction Studies

EMAP: Environmental Monitoring and Assessment Program
http://www.epa.gov.emap/
http://yosemite.epa.gov/r10/oea.nsf/1887fc8b0c8f2aee8825648f00528583/f7a660b35e5d96df882568790053fc10?OpenDocument
ENSO: El Niño Southern Oscillation
EOSDIS: EOS Data and Information System
http://spsosun.gsfc.nasa.gov/NewEOSDIS_Over.html
EPA: U.S. Environmental Protection Agency
ERMS: European Register of Marine Species
ERS-1: European Remote Sensing satellite-1
ERS-2: European Remote Sensing satallite-2
ESH (NSF): Marine Aspects of Earth System History
ESP: Eastern South Pacific
ETL tools: Extraction, Transformation, and Loading tools
EU: European Union
EUMETSAT: European Organization for the Exploitation of Meteorological Satellites
EuroGOOS: European GOOS
EuroHAB: European Harmful Algae Bloom
EVOS: Exxon Valdez Oil Spill http://www.oilspill.state.ak.us/
Bibliography: http://www.oilspill.state.ak.us/Biblio/biblio.htm
Final and Annual Reports: http://www.oilspill.state.ak.us/reports/clusters.htm
F & A: Finance and Administration Committee (PICES)
FCCC: Framework Convention on Climate Change
Federal Geographic Data Committee metadata requirements:
http://www.fgdc.gov/metadata/metadata.html
Federal Subsistence Fishery Monitoring Program, Federal Subsistence Management Program
http://www.r7.fws.gov/asm/home.html
FGDC: Federal Geographic Data Committee
FIS: Fishery Science Committee (PICES)
Fishbase, FishGopher, FishNet: searchable fish databases managed by multiple organizations
FMP: Fishery Management Plan
FOCI: Fisheries Oceanography Investigations
http://rho.pmel.noaa.gov/card/long/home_page.html
F-R: Fundraising Committee (PICES)
FY: Fiscal Year
GAIM: Global Analysis, Interpretation and Modelling (IGBP)
GAK: Gulf of Alaska
GAP: Gap Analysis Program
GARP: Genetic Algorithm for Rule-set Production
GBIF: Global Biodiversity Information Facility
GC: Governing Council (PICES)
GCM: Global Climate Model
GCN: Global Core Network
GCOS: Global Climate Observing System
http://193.135.216.2/web/gcos/pub/dim_v1_1.html

GCRMN: Global Coral Reef Monitoring Network
GCTE: Global Change and Terrestrial Ecosystems (IGBP)
GEF: Global Environmental Facility
GEOHAB: Global Ecology of Harmful Algal Blooms
GEM: Gulf Ecosystem Monitoring
GEO: Global Eulerian Observations
GHL: Guideline Harvest Level
GIPME: Global Investigation of Pollution in the Marine Environment
GIS: Geographic Information System
GIWA: Global International Water Assessment
GLI: Global Imager
GLOBE: Global Learning and Observations to Benefit the Environment
    http://www.globe.gov
GLOBEC: Global Climate Change
    http://cbl.umces.edu/fogarty/usglobec/
GLORIA: Geological Long-Range Inclined Asdic
GLOSS: Global Sea-Level Observing System
GMBIS: Gulf of Marine Biogeographic Information System
GNP: Gross National Product
GOA: Gulf of Alaska
GODAE: Global Ocean Data Assimilation Experiment
GOES: Geostationary Operational Environmental Satellite
GOOS: Global Ocean Observing System
    http://www.gos.udel.edu
GPA/LBA: Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities
GPO: GOOS Project Office
GPS: Global Positioning System
GSC: GOOS Steering Committee
GTOS: Global Terrestrial Observing System
GTS: Global Telecommunications System
GUI: Graphical User Interface
HAB: harmful algal bloom
    http://www.redtide.whoi.edu/hab
HABSOS: Harmful Algal Bloom Observing System
    http://www.habhrca.noaa.gov
HAPC: Habitat Areas of Particular Concern
HELCOM: Helsinki Commission-Baltic Marine Environment Protection Commission
HMAP: History of Marine Animal Populations
HMS: Hydrometeorological Service
HNLC: high nitrate, low chlorophyll waters
HOTO: Health of the Oceans
HPLC: High Performance Liquid Chromatography
IABIN: Inter-American Biodiversity Information Network
IAI: Inter-American Institute

IARC: International Arctic Research Center, University of Alaska
http://www.iarc.uaf.edu/
IARPC: Interagency Arctic Research Policy Committee
http://www.nsf.gov/od/opp/arctic/iarpc/start.htm
IBOY: International Biodiversity Observation Year
IBQ: Individual Bycatch Quota
ICAM: Integrated Coastal Area Management
/ Integrated Coastal Area Management Programme
ICES: International Council for the Exploitation of the Sea
ICLARM: International Center for Living Aquatic Resources Management
ICM: Integrated Coastal Management
ICSU: International Council for Science
ICZN: International Code of Zoological Nomenclature
IFEP: Iron Fertilization Experiment Panel (PICES)
IFQ: Individual Fishing Quota
IGAC: International Global Atmospheric Chemistry Project (IGBP/CACGP)
IGBP: International Geosphere-Biosphere Programme
http://www.igbp.kva.se/
IGBP-DIS: Data and Information System (IGBP)
I-GOOS: IOC-WMO-UNEP Committee for the Global Ocean Observing System
IGOS (NASA): Integrated Global Observing System
IGOSS: Integrated Global Ocean Services System
IGS: International GPS Service for Geodynamics
IGU: International Geographic Union
IHDP: International Human Dimensions Programme on Global Environmental Change
IIP: International Ice Patrol
I-LTER: International LTER
IMS: Institute of Marine Science, University of Alaska
InfoBOOS: BOOS Information System
INPFC: International North Pacific Fisheries Commission
http://www.npafc.org/inpfc/inpfc.html
IOC: Intergovernmental Oceanographic Commission (of UNESCO)
http://ioc.unesco.org/iyo/
IOCCG: International Ocean-Color Coordinating Group
IODE: International Oceanographic Data and Information Exchange
http://ioc.unesco.org/iode/index.htm
IOOS: Integrated Ocean Observing System
http://core.ssc.erc.msstate.edu/oceanobs.html
IPCC: Intergovernmental Panel on Climate Change
IPHAB: Intergovernmental Panel on HABs
IPHC: International Pacific Halibut Commission
http://www.iphc.washington.edu/)
IPSFC: International Pacific Salmon Fishing Commission
IRFA: Initial Regulatory Flexibility Analysis
IRIU: Improved Retention/Improved Utilization

ITAC: Initial Total Allowable Catch
ITIS: Integrated Taxonomic Information System
ITSU: IOC Tsunami Warning System in the Pacific
IUCN: The World Conservation Union
Japanese ADEOS-2 satellite: http://seawinds.jpl.nasa.gov
JCOMM: Joint Technical Commission for Oceanography and Marine Meteorology
JDBC: Java Database Connectivity
JDIMP: Joint Data and Information Management Panel
JGOFS (NSF): Joint Global Ocean Flux Study
http://ads.smr.uib.no/jgofs/jgofs.htm
KBNERR: Kachemak Bay Ecological Characterization study
http://www.state.ak.us/adfg/habitat/geninfo/nerr/kbec/index.htm
KRSA: Kenai River Sportfishing Association
LAMP: Local Area Management Plan
LATEX: Louisiana-Texas shelf study
LEO: Long-term Ecosystem Observatory
LEO-15: Long-term Ecosystem Observatory at 15-m depth
LExEn (NSF): Life in Extreme Environments
LIDAR: Light Detection and Ranging
List of oceanographic data servers: http://gcmd.gsfc.nasa.gov/pointers/ocean.html
LLP: License Limitation Program
LMR: Living Marine Resources
LOICZ: Land-Ocean Interactions in Coastal Zone
LTER: Long-term Ecological Research (NSF) http://lternet.edu/
LUCC: Land Use/Cover Change (IGBP/IHDP)
MABNET: Man and the Biosphere Network
MARBID: Marine Biodiversity Database
MARGINS (NSF): Continental Margins
MarLIN: Marine Laboratories Information Network
MAROB: Marine Observation
MAST: Marine Science and Technology
MBARI: Monterey Bay Aquarium Research Institute
http://www.mbari.org/about/
MBF: One thousand board feet
MBMAP: Advisory Panel on Marine Birds and Mammals (PICES)
MBNMS: Monterey Bay National Marine Sanctuary
http://bonita.mbnms.nos.noaa.gov/research/mb_workshop/index.html
MEHRL: Marine Environmental Health Research Laboratory
http://www.cofc.edu/~grice/mehrl
MEL: Master Environmental Library
http://www-mel.nrlmry.navy.mil/
MEQ: Marine Environmental Quality Committee (PICES)
MERIS: Medium Resolution Imaging Spectrometer
MetOp: Meteorological Operational
MFS: Mediterranean Forecasting System

MMPA: Marine Mammal Protection Act
MMRC: The North Pacific Universities Marine Mammal Research Consortium
consortium@zoology.ubc.ca
MMS: Minerals Management Service
MMS OCSES: Outer Continental Shelf Environmental Studies
MPA: Marine Protected Areas (DOC/DOI)
http://www.mpa.gov
MODEL: Conceptual / Theoretical and Modeling Studies Task Team (PICES)
MODIS: Moderate Resolution Imaging Spectroradiometer
MONITOR: Monitor Task Team (PICES)
MOOS: Ocean Observing System of the Monterey Bay Aquarium Research Institute
http://www.mbari.org/default.htm
MOS: Modular Optoelectronic Scanner
MSFCMA: Magnuson-Stevens Fishery Conservation and Management Act
MRB: Maximum Retainable Bycatch
MSY: Maximum Sustainable Yield
mt: Metric tons
NA: Northern Adriatic
NABIN: North American Biodiversity Information Network
NABIS: National Aquatic Biodiversity Information Strategy
NAML: National Association of Marine Laboratories
NAO: North Atlantic Oscillation
NASA: National Aeronautics and Space Administration
NASA/AMSR: Advance Microwave Scanning Radiometer:
http://wwwghcc.msfc.nasa.gov/AMSR/
Earth Science Enterprise: http://www.earth.nasa.gov
TOPEX/Poseiden: http://topex-www.jpl.nasa.gov
NASA/NASDA Tropical Rainfall Measurement Mission:
http://ltpwww.gsfc.nasa.gov/MODIS/MODIS.html
NASA/SeaWiFS: http://seawifs.gsfc.nasa.gov
NASA/GRACE: Gravity Recovery and Climate Experiment:
http://essp.gsfc.nasa.gov/esspmissions.html
NASA/Salinity and Sea Ice Working Group:
http://www.esr.org/lagerloef/ssiwg/ssiwgrep1.v2.html
Naval Oceanographic Office
http://128.160.23.51/noframe/select.products.htm
NAWQA: National Water Quality Assessment Program
NCAR: National Center for Atmospheric Research
NCDC: National Climate Data Center
http://www.ncdc.noaa.gov/
NCEP: National Centers for Environmental Protection
NDBC: National Data Buoy Center
NDVI: Normalized Difference Vegetation Index
NEAR-GOOS: North East Asian GOOS
NEMO: Naval Earth Map Observer

NEODAT: Inter-Institutional Database of Fish Biodiversity in the Neotrophics
NEP: National Estuarary Program
NERR: National Estuarine Research Reserve
NESDIS: National Environmental Satellite, Data, and Information Service
NGO: Non-governmental organization
NGOA: Northern Gulf of Alaska
NIST: National Institute of Standards and Technology
http://www.nist.gov/
NIWA: National Institute of Water and Atmosphere Research
NMFS: National Marine Fisheries Service
http://www.nmfs.gov/
NMMHSRP: National Marine Mammal Health and Stranding Response Program
http://www.nmfs.gov/prot_res/overview/mmhealth.html
NMML: National Marine Mammal Laboratory
http://nmml.afsc.noaa.gov/AlaskaEcosystems/sslhome/FILEINFO.htm
NOAA: National Oceanic and Atmospheric Administration
NOAA HAZMAT: Hazardous Materials Program
NOAA NOS: National Ocean Service
NODC: National Oceanographic Data Center
http://www.nodc.noaa.gov
NOLS: National Outdoor Leadership School
NOPP (NASA): National Ocean Partnership Program
http://core.ssc.erc.msstate.edu/NOPPpg1.html
NOPPO: National Oceanographic Partnership Program Office
NORLC: National Ocean Research Leadership Council
NORPAC: North Pacific; an informally organized group of scientists responsible for collating and publishing much of the oceanographic data collected in the North Pacific Ocean during the period of approximately 1930 to 1965. These data were published in several volumes by the University of California Press. This data set is collectively known as the NORPAC data.
NOS: National Ocean Service
http://www.nos.noaa.gov/
NPAFC: North Pacific Anadromous Fish Commission
http://www.npafc.org
http://www.pac.dfo-mpo.gc.ca/sci/pbs/pages/NPAFC.htm
NPFMC: North Pacific Fishery Management Council
NPDES: National Pollution Discharge Elimination System
NPO: North Pacific Oscillation
NPOESS: National Polar-Orbiting Environmental Satellite System
NPS: National Park Service
NRC: National Research Council
NRT: Near Real Time
NS&T: National Status and Trends Program
http://ccmaserver.nos.noaa.gov/NSandT/New_NSandT.html
NSF: National Science Foundation
NSIPP (NASA): Seasonal-to-Interannual Prediction Program

NURP (NOAA): National Undersea Research Program
NVODS: National Virtual Ocean Data System
NVP: Nearshore Vertebrate Predator project
NWP: numerical weather prediction
NWS: National Weather Service
 http://www.nws.noaa.gov/
OAR: Office of Oceanic and Atmospheric Research (NOAA)
 http://oar.noaa.gov/
OBIS: Ocean Biogeographical Information System
 www.coml.org
OCC: Ocean Carrying Capacity
OCSEAP: Outer Continental Shelf Environmental Assessment Program
OCTS: Ocean Color and Temperature Scanner
OE (NOAA OAR) Office of Ocean Exploration
 http://oceanpanel.nos.noaa.gov/
OECD: Organization for Economic Co-operation and Development
OFP: Ocean Flux Program
OMB: Office of Management and Budget
OOPC: Ocean Observations Panel for Climate
OOSDP: Ocean Observing System Development Panel
OPA 90: Oil Pollution Act of 1990
 http://www.pwssc-osri.org/docs/opa90.html
OPR: Office of Protected Resources
 http://www.nmfs.gov/prot_res/prot_res.html
ORAP: Ocean Research Advisory Panel
OSNLR: Ocean Science in Relation to Non-Living Resources
OSPARCOM: Convention for the Protection of the Marine Environment of the North-east Atlantic
OSSE: Observation System Simulation Experiments
OSRI: Prince William Sound Oil Spill Recovery Institute
 http://www.pwssc-osri.org/mission/mission.fr.html
OSTP: Office of Science and Technology Policy
OY: Optimum yield
PAG: Public Advisory Group
PAGES: Past Global Change (IGBP)
PAH: Polyaromatic hydrocarbons
PAR: Phosynthetically Available Radiation
PC: Publication Committee (PICES)
PCAST: President's Committee of Advisors on Science and Technology
PCB: Polychlorinated biphenyls
PCC: Pollock Conservation Cooperative
PDO: Pacific Decadal Oscillation
PICES: North Pacific Marine Science Organization (not an acronym)
 http://pices.ios.bc.ca/
PICES Technical Committee on Data Exchange: http://pices.ios.bc.ca/data/dataf.htm

PICES Data Bases: http://pices.ios.bc.ca/data/weblist/weblist.htm
PIRATA: Pilot Research Array in the Tropical Atlantic
PISCO: Partnership for the Interdisciplinary Study of Coastal Oceans
http://www.piscoweb.org/
PMEL: Pacific Marine Environmental Laboratory
http://www.pmel.noaa.gov/
PMEL Bering Sea and North Pacific Ocean Theme Page: www.pmel.noaa.gov/bering
POC: Physical Oceanography and Climate Committee (PICES)
POLDER: Polarization and Directionality of the Earth's Reflectances
POM: Princeton Ocean Model
PORTS: Physical Oceanographic Real-Time System
PORTS/VTS: PORTS/Vessel Traffic Services
PRODAS: Prototype Ocean Data Analysis System
PROFC: Programa Regional de Oceanografia Fisica y Clima
PSC: Pacific Salmon Commission
http://www.psc.org/Index.htm
PSMFC: Pacific States Marine Fisheries Commission
http://www.psmfc.org/
PSMFC Regional Mark Processing Center: http://www.rmis.org/index.html
PSP: Paralytic Shellfish Poisoning
PST: Pacific Salmon Treaty
PWS: Prince William Sound
PWSAC: PWS Aquaculture Corporation http://www.ctcak.net/~pwsac/
PWSRCAC: PWS Regional Citizens Advisory Council
PWSSC: Prince William Sound Science Center
http://www.pwssc-osri.org/
QAQC: Quality Assurance and Quality Control
QC: quality control
QUIJOTE: Quickly Integrated Joint Observing Team
R&D: Research and Development
RACE: Resource Assessment and Community Ecology
RAMS: Regional Atmospheric Modeling System
RCAC: Regional Citizens Advisory Council
RCRA: Resource Conservation and Recovery Act
RDP: Ribosomal Database Project
REX: Regional Experiments Task Team (PICES)
RIDGE (NSF): Ridge Interdisciplinary Global Experiments
RMI: Remote Method Invocation
RLDC: Responsible Local Data Center
RLDC: Responsible Local Data Center
RNODC: Responsible National Oceanographic Data Center
RSN: RedSur Network
S1: Session 1 – Science Board Symposium on Subarctic gyre processes and their interaction with coastal and transition zones: physical and biological relationships and ecosystem impacts (PICES)

S2: Session 2 – BIO Topic Session on Prey consumption by higher trophic level predators in PICES regions: implications for ecosystem studies (PICES)
S3: Session 3 – Joint BIO / CCCC Topic Session on Recent progress in zooplankton ecology study in PICES regions (PICES)
S4: Session 4 – FIS Topic Session on Short life-span quid and fish as keystone species in North Pacific marine ecosystems (PICES)
S5: Session 5 – POC Topic Session on Large-scale circulation in the North Pacific (PICES)
S6: Session 6 – Joint POC / BIO Topic Session on North Pacific carbon cycling and ecosystem dynamics (PICES)
S7: Session 7 – CCCC Topic Session on Recent findings and comparisons of GLOBEC and GLOBEC-like programs in the North Pacific (PICES)
S8: Session 8 – MEQ Topic Session on Environmental assessment of Vancouver Harbour: results of an international workshop (PICES)
S9: Session 9 – MEQ Topic Session on Science and technology for environmentally sustainable mariculture in coastal areas (PICES)
SAFE: Stock Assessment and Fishery Evaluation Document
SAR: Synthetic Aperture Radar
SB: Science Board (PICES)
SBIA (NSF): Shelf-basin Interactions in the Arctic
SCAMIT: Southern California Association of Marine Invertebrate Taxonomists
SC(-IGBP): Scientific Committee for the IGBP
SCICEX (NSF): Science Ice Exercise
SCOPE: Scientific Committee on Problems of the Environment
SCOR: Scientific Committee on Oceanic Research
SCS: South China Sea
SEA: Sound Ecosystem Assessment
SEARCH: Study of Environmental Arctic Change
SEAS: Shipboard Environmental Data Acquisition System
SeaWIFS: Sea-viewing Wide Field-of-view Sensor
SEI: Special Events Imager
SEPOA: Southeast Pacific Ocean Array
SFOS: School of Fisheries and Ocean Sciences
SG: Sea Grant
    http://www.nsgo.seagrant.org/
SGI: State of the Gulf Index
SHEBA (NSF): Surface Heat Budget of the Arctic Ocean
SIMBIOS: Sensor Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies
SIMoN: Sanctuary Integrated Monitoring Network
    http://www.mbnms.nos.noaa.gov/Research/simon/simon.htm
SLFMR: Scanning Low Frequency Microwave Radiometers
SO-GLOBEC: Southern Ocean Programme (GLOBEC)
SOIREE: Southern Ocean iron release experiment
    http://katipo.niwa.cri.nz/~hadfield/gust/iron
SOLAS: International Convention for Safety of Life at Sea

SPACC: Small Pelagic Fish and Climate Change (GLOBEC)
Specimen Banking Project
    http://www.nwfsc.noaa.gov/pubs/tm/tm16/tm16.htm
SQuID: Structured Query and Information Delivery
SSC: Scientific and Statistical Committee
SSE (NOAA): Sustainable Seas Expedition
SSF: Storm Surge Forecast System
SSH: Sea Surface Height
SSM/I: Special Sensor Microwave/Imager
SSS: Sea Surface Salinity
SST: Sea Surface Temperature
STAMP: Seabird Tissue Archival Monitoring Project
START: Global Change System for Analysis, Research and Training (IGBP)
STD: Salinity Temperature Depth recorder
STORET System (EPA)
    http://www.epa.gov/owow/STORET
SWAO: South western Atlantic Ocean
TAC: Total allowable catch
TAO: Tropical Atmosphere Ocean (buoy array)
    http://www.pmel.noaa.gov/toga0tao/review98/data.html
TASC: Transatlantic Study of Calanus finmarchicus (EU)
TCODE: Technical Committee on Data Exchange (PICES)
TCP: Tropical Cyclone Programme
TEMA: Training, Education and Mutural Assistance (IOC)
TOGA: Tropical Ocean and Global Atmosphere
T/P: TOPEX/Poseidon
UAA: University of Alaska, Anchorage
UAF: University of Alaska, Fairbanks
UN: United Nations
UNCED: The United Nations Conference on Environment and Development
UNCLOS: United National Convention on the Law of the Sea (Montego Bay, 1982)
UNEP: United Nations Environmental Programme
UNESCO: United Nations Educational, Scientific and Cultural Organization
    http://ioc.unesco.org/iocweb/
UNFCCC: United Nations Framework Convention on Climate Change
USARC: U.S. Arctic Research Commission
USCG: U.S. Coast Guard
USDA: U.S. Department of Agriculture
USFS: U.S. Forest Service
USGCRP (NASA): U.S.Global Climate Research Program
USGS: U.S. Geological Survey
    http://www.usgs.gov/
US GLOBEC (NSF): U.S. Global Ocean Ecosystems Dynamics
    http://cbl.umces.edu/fogarty/usglobec/

USNO: U.S. Naval Observatory
http://www.usno.navy.mil/
VBA: Vessel Bycatch Accounting
VENTS (NOAA): Vents Program
VIP: Vessel Incentive Program
VOS: Volunteer Observing Ships
W1: Workshop 1 – MONITOR Workshop on Progress in monitoring the North Pacific (PICES)
W2: Workshop 2 – REX Workshop on Trends in herring populations and trophodynamics (PICES)
W3: Workshop 3 – MODEL Workshop on Strategies for coupling higher and lower trophic level marine ecosystem models (PICES)
W4: Workshop 4 – BASS Workshop of Development of a conceptual model of the Subarctic Pacific basin ecosystem(s) (PICES)
W5: Workshop 5 – IFEP Planning Workshop on Designing the iron fertilization experiment in the Subarctic Pacific (PICES)
W6: Workshop 6 – (BIO / MBMAP) – The basis for estimating the abundance of marine birds and mammals, and the impact of their predation on other organisms (PICES)
W7: Workshop 7 – CO2 Data Synthesis Symposium (PICES)
WAM: Wave Model
WCRP: World Climate Research Program (ICSU/IOC/WMO)
WES: Waterways Experimental Station
WESTPAC: IOC Sub-Commission for the Western Pacific
WG: Working Group (PICES)
WHOI: Woods Hole Oceanographic Institution
WMO: World Meteorological Organization
WOCE (NSF): World Ocean Circulation Experiment (WCRP)
http://www.soc.soton.ac.uk/OTHERS/woceipo/ipo.html
http://www.cms.udel.edu.woce/
WOOD: World-wide Oceans Optics Database
WODC: World Oceanographic Data Center
WWW: World Weather Watch
XBT: expendable bathythermograph
XCDT: expendable conductivity, depth and salinity devices

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

AGENDA
EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
MEETING
August 6, 2001 8:30 a.m.
645 G STREET, Suite 401, ANCHORAGE

DRAFT

Trustee Council Members:

CRAIG TILLERY
Assistant Attorney General
State of Alaska

MICHELE BROWN (Marianne See)
Commissioner
Alaska Department of Environmental Conservation

DAVID ALLEN (Cam Toohey)
Director, Alaska Region
U.S. Fish and Wildlife Service

DAVE GIBBONS
U.S. Department of Agriculture
Forest Service

JAMES W. BALSIGER
Director, Alaska Region
National Marine Fisheries Service

FRANK RUE
Commissioner
Alaska Department of Fish & Game

Teleconferenced in Anchorage, Restoration Office, 645 G Street
State Chair

1. Call to Order - 8:30 a.m.
    - Approval of Agenda
    - Approval of Meeting notes
        May 3, 2001

2. Executive Director's Report - Molly McCammon - 8:35 a.m.
    Administrative Issues
        -Report to Congress
        -Draft MOA with other funding organizations
        -Investments
        -Final report (Project 01535)*
        -Office move*
    Habitat
        -Status of large and small parcel programs*
        -Extend offer on UA parcels*
        -Habitat grant
    Science/Work Plan
        -Oceans symposium
        -GEM writing contract*

3. Public Advisory Group Report - Chuck Meacham - 9:00 a.m.

4. Afognak Island habitat effort - Jerry Wells, Rocky Mountain Elk Foundation - 9:15 a.m.

5. Archaeology status report - Veronica Christman - 9:45 a.m.

6. Public comment period - 10:00 a.m.

7. Lingering oil status report - Jeff Short - 10:30 a.m.

8. GEM*

9. Executive Session (legal issues, possibly habitat) - Lunch provided

10. FY 02 Work Plan*

Adjourn 5:00 p.m.

* indicates tentative action items

DRAFT

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451   907/278-8012 fax:907/276-7178

TRUSTEE COUNCIL MEETING ACTIONS

May 3, 2001

By Molly McCammon
Executive Director

Trustee Council Members Present:

●Dave Gibbons, USFS	●Frank Rue, ADF&G
*Dave Allen, USFWS	Michele Brown, ADEC
James Balsiger, NMFS	Craig Tillery, ADOL

* Chair
In Anchorage: Allen, and Slater.
By teleconference in Juneau: Balsiger, and Lisowski.
By teleconference in Anchorage: Brown, and Tillery.

● Alternates:

Claudia Slater served as an alternate for Frank Rue for the entire meeting.
Maria Lisowski served as an alternate for Dave Gibbons for the entire meeting.

Meeting convened at 10:08 a.m., May 3, 2001

1. Approval of the Agenda

APPROVED MOTION: Approved the Agenda.

Motion by Tillery, second by Lisowski .

2. Approval of the Meeting Notes

APPROVED MOTION: Approved April 3, 2001 Trustee Council meeting notes.

Motion by Tillery, second by Balsiger.

Public comment period began at 10:10 a.m.

Public comments received telephonically from 1 individual in Seward.

Public comment period closed at 10:15 a.m.

3. Project 01190

APPROVED MOTION: Approval of an additional $4,300.00 for Project 01190, "Construction of a Linkage Map for the Pink Salmon Genome".

Motion by Balsiger, second by Lisowski.

4. Old Harbor Hydroelectric Project

APPROVED MOTION: Adopted resolution 01-11 (Attachment A). The Trustee Council supports an amendment to the conservation easement conveyed by Old Harbor Native Corporation to the State of Alaska solely to permit the construction, operation, and maintenance of the Project as licensed by FERC, so long as the hydroelectric project is constructed in accordance with the terms and conditions of the FERC license at the location on the attached map (Resolution 01-11- Attachment C), except that if a pond is necessary to equalize water temperatures, the location and size of the pond must be approved by the Alaska Department of Fish and Game.

Motion by Tillery, second by Balsiger.

5. Small parcel, KAP 2069

APPROVED MOTION: Adopted resolution 01-09 (Attachment B), providing $12,000 for the United States Fish and Wildlife Service to offer to purchase and, if the offer is accepted, to purchase all of the seller's rights and interests in parcel KAP 2069; and to provide funds necessary for closing costs recommended by the Executive Director of the Trustee Council and approved by the Trustee Council and pursuant to the conditions as stated in the resolution.

Motion by Allen, second by Tillery.

6. Small parcel, KEN 294

APPROVED MOTION: Adopted resolution 01-10 (Attachment C), providing $78,000 for the United States Fish and Wildlife Service to offer to purchase and, if the offer is accepted, to purchase all of the seller's rights and interests in parcel KEN 294; and to provide funds necessary for closing costs recommended by the Executive Director of the Trustee Council and approved by the Trustee Council and pursuant to the conditions as stated in the resolution.

Motion by Slater, second by Tillery.

7. Project 99514

APPROVED MOTION: Approved a motion to designate the Chugach Regional Resources Commission to be the named recipient of a future grant for implementing the waste management plan for the lower Cook Inlet, because they will be the most efficient and effective entity to administer such grant. A detailed proposal of how the funds will be spent will be presented to the Trustee Council at a later date.

Motion by Balsiger, second by Lisowski.

Meeting adjourned 11:11a.m.

Report to Congress

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

MEMORANDUM

TO: Trustee Council

FROM: Molly McCammon
Executive Director

DATE: July 30, 2001

RE: Report to Congress

In the federal statute authorizing the Trustee Council to move the *Exxon Valdez* oil spill settlement funds outside the U.S. Treasury, Congress included a section (attached) that conditions continuation of this authority upon submittal of a report to Congress by September 30, 2001 recommending "a structure the Trustees believe would be most effective and appropriate for the administration and expenditure of remaining funds and interest received".

I am currently preparing a draft report that will include the following elements:

- Two identical letters, one to the President of the Senate (the Vice-President) and one to the Speaker of the House. The letters would be signed by the six members of the Trustee Council. On the federal side, the Trustee Council members would sign on behalf of their trustees. Copies of the letters would be sent to the Alaska Delegation and the Governor.
- One section of the report would summarize the comments received on governance during the public comment period for the Restoration Reserve. Out of more than 2400 responses, only 265 commented on governance. Of those, about half recommended keeping the current Trustee Council and about half suggested a new board.
- The Trustee Council recommendation will be to keep the current Trustee Council for management and administration of the settlement funds at least until September 2006. There are a number of reasons for this:

  --The investment authority and how investments are currently managed are still very new and need management continuity until they have been fully tested.

  --The GEM Program is still under review and development, and will take at least 4-5 years to be fully operational.

--We are still seeing the effects of lingering oil spill injury in the spill region.
--The current habitat and science programs require a number of coordinated efforts for implementation. Changing management at this stage of the program would be problematic.

- A recommendation that this issue be reconsidered in 2006 or earlier if the Trustee Council decides it is appropriate.
- On the state side, the state trustees would need to ensure that this position is supported by the governor. On the federal side, the language needs to be cleared by the Office of Management and Budget. It may also need to be cleared by each federal trustee.

I propose to finalize the draft of this report, which will be very short, and circulate it by August 10 for your review. I would hope we could have fairly quick turnaround of the exact language so that we can move forward with review by the governor and OMB. At the August 6 meeting, I would like your concurrence with this approach.

Attachment

Desert Storm" Act of 1992 (Public Law 102-229; 42 U.S.C. 1474b note) that amounts received by the United States and designated by the trustees for the expenditure by or through a Federal agency must be deposited into the Fund.

(5) All remaining settlement funds are eligible for the investment authority granted under this section so long as they are managed and allocated consistent with the Resolution of the Trustees adopted March 1, 1999, concerning the Restoration Reserve as follows:

(A) $55 million of the funds remaining on October 1, 2002, and the associated earnings thereafter shall be managed and allocated for habitat protection programs including small parcel habitat acquisitions. Such sums shall be reduced by—

(i) the amount of any payments made after the date of enactment of this Act from the Joint Trust Funds pursuant to an agreement between the Trustee Council and Koniag, Inc., which includes those lands which are presently subject to the Koniag Non-Development Easement, including, but not limited to, the continuation or modification of such Easement; and

(ii) payments in excess of $6.32 million for any habitat acquisition or protection from the joint trust funds after the date of enactment of this Act and prior to October 1, 2002, other than payments for which the Council is currently obligated through purchase agreements with the Kodiak Island Borough, Afognak Joint Venture and the Eyak Corporation.

(B) All other funds remaining on October 1, 2002, and the associated earnings shall be used to fund a program, consisting of—

(i) marine research, including applied fisheries research;

(ii) monitoring; and

(iii) restoration, other than habitat acquisition, which may include community and economic restoration projects and facilities (including projects proposed by the communities of the EVOS Region or the fishing industry), consistent with the Consent Decree.

(6) The Federal trustees and the State trustees, to the extent authorized by State law, are authorized to issue grants as needed to implement this program.

(7) The authority provided in this section shall expire on September 30, 2002, unless by September 30, 2001, the Trustees have submitted to the Congress a report recommending a structure the Trustees believe would be most effective and appropriate for the administration and expenditure of remaining funds and interest received. Upon the expiration of the authorities granted in this section all monies in the Fund or outside accounts shall be returned to the Court Registry or other account permitted by law.

SEC. 351. YOUTH CONSERVATION CORPS AND RELATED PARTNERSHIPS.

(a) Notwithstanding any other provision of this Act, there shall be available for high priority projects which shall be carried out by the Youth Conservation Corps as authorized by Public Law 91-378, or related partnerships with non-Federal youth conservation corps or entities such as the Student Conservation Association, up to $1,000,000 of the funds available to the Bureau of Land Management under this Act, in order to increase the number of [illegible]

ACE 30396377

[illegible] A

[illegible] 3 [illegible] 3

Memorandum of Understanding

Between the State of Alaska

- Department of Administration (DOA);
- Department of Community and Economic Development (DCED);
- Department of Corrections; (DOC)
- Department of Education and Early Development; (DEED)
- Department of Environmental Conservation; (DEC)
- Department of Health and Social Services; (DHSS)

- Department of Labor and Workforce Development; (DOL&WD)
- Department of Military and Veterans Affairs; (DMVA)
- Department of Natural Resources; (DNR)
- Department of Transportation and Public Facilities; (DOT&PF)
- University of Alaska; (U of A)

Also

- Denali Commission;
- U. S. Department of Agriculture (USDA), Rural, Alaska Office;
- U. S. Department of Commerce Economic Development Administration, Western Region (EDA); U.S. Commercial Service
- U. S. Department of Housing and Urban Development (HUD); and
- U. S. Department of Interior Bureau of Indian Affairs (BIA), Alaska Office.

Background

The Denali Commission Act of 1998, as amended (Division C, Title III, PL 105-277) (Act) states that the purposes of the Denali Commission are to:

1. Deliver the services of the Federal Government in the most cost-effective manner practicable by reducing administrative and overhead costs;
2. Provide job training and other economic development services in rural communities, particularly distressed communities; and
3. Promote rural development, provide power generation and transmission facilities.

The Act recognizes that these purposes can only be accomplished through a collaborative, coordinated effort by the State of Alaska and key federal agencies. The State of Alaska also recognizes the above benefits can be furthered if State agencies work in a collaborative and coordinated effort.

Purpose

This Memorandum of Understanding (MOU) outlines some points of agreement that will facilitate the collaboration and coordination necessary for achievement of the purposes of the Denali Commission and related missions of agencies who are parties to this MOU.

Points of Agreement

The parties to this MOU agree the following are a key element in achieving shared goals:

1) **Community plans.** A single community strategic plan should be sufficient to identify and establish the priorities of each rural community. To be effective, the plan must be value-based; based on significant community participation and support; approved by the city and tribal councils and village corporation (if these entities exist); and take into account regional priorities.

   The parties to this MOU agree to:
   a) Support the development of comprehensive community plans where an acceptable comprehensive plan does not now exist; (USDA Rural Development, in collaboration with the Denali Commission, has developed a model planning process);
   b) Support the concept of a single comprehensive community plan and utilize comprehensive community plans (or other acceptable plans that currently exist) as the basis for determining priorities in a community;
   c) Work to coordinate the timing for service and project delivery so that projects are "whole" and sequenced most effectively (e.g. constructing road, water, and sewer for housing project in an orderly fashion).

2) **Regional strategies.** Systematic planning and coordination on a local, regional and statewide basis are necessary to achieve the most effective results from investments in infrastructure, economic development and training. Because Alaska is so vast and the regions of Alaska are unique, ideally these needs and priorities would be based on community plans presented as a regional strategy.

   The parties to this MOU agree:
   a) To develop a protocol that weaves together many existing regional planning efforts, maximizing development and delivery of resources.
   b) A State-recognized regional strategy should be:
      - Based on community strategic plans that are value-based and comprehensive (more than a project list) and approved by the city council, tribal government, and village corporation, if applicable;
      - A balance of local, regional, and State identified needs, including needs identified by existing regional and sub-regional economic development organizations; any borough in the region; the regional Native profit and non-profit corporations; any other significant economic development "drivers"; and State and federal agencies doing work in the region.

- Approved by the regional entities, (an entity recognized and agreed be it an ARDOR, native regional non-profit or some other regional structure; and
- Reflect existing State and federal agency approved plans, or a written agreement by an agency to change the approved plan.

c) To collaborate on the development of a single uniform federal and state funding application and reporting process. The purpose of this effort is to reduce the administrative burden on communities.

3) **Regional Funding Summits.** The USDA Rural Development, Denali Commission and DCED, have held and plan to organize future regional funding summits. While the purpose of the summits is to help communities and regions fund their priority project(s), another long-term goal of the summits is to provide an opportunity for agencies and local and regional participants to discuss community and regional economic development issues and opportunities. Projects discussed at the summit must have municipal and tribal support and must be the result of a community planning process. Each project is reviewed and potential funders are identified.

   Communities present their priority project(s) and agencies and community and regional representatives jointly scope available resources and assign a lead agency contact.

   The parties to this MOU agree to:

   a) Participate in the regional funding summits if the agency has funds or other available resources. (e.g. technical assistance)

4) **Rural Alaska Project Identification Delivery System (RAPIDS).** The RAPIDS database maintained by the state's Department of Community and Economic Development provides information on completed and planned projects for most rural Alaska communities. The goal is to expand RAPIDS to include appropriate information for all communities in rural Alaska and regional projects.

   The parties to this MOU agree to:

   a) Participate in the enhancement of RAPIDS by providing ideas and information.
   b) Contribute all appropriate updated information at least annually.
   c) Utilize RAPIDS as a management tool to achieve coordination and maximize the efficient use of available resources.

5) **Alaska Economic Information System.** The goal is to create and provide for the maintenance of a system of information relevant to economic development in Alaska, ultimately web-based. Components of

the AEIS include but are not limited to DCED's Economic Data Mapping Project, Community Database, and Rural Alaska Project Identification Delivery System (RAPIDS); and, DOL's "Polaris" Project. The AEIS will provide information for decision-making and be a vehicle for coordination and collaboration between local, regional, State and federal entities.

The parties to this MOU agree to:

a) Participate in the development of the AEIS by providing ideas and information.
b) Contribute all appropriate updated information at least annually.
c) Utilize AEIS as a management tool to achieve coordination and maximize the efficient use of available economic development resources.

6) **Regional Economic Development Initiative (REDI).** REDI is intended to 1) create links between job placement, training, and community and economic development; and 2) enhance the communication between a region and the Governor's Jobs Cabinet. The seven regions targeted by REDI are Southeast, Gulf Coast, Anchorage-Mat/Su, Southwest, Yukon-Kuskokwim Delta, Interior, and Northern. Each region has a designated DOL/DCED captain and co-captain who are responsible for organizing the teleconference and compiling regional reports. In the teleconferences, DOL and DCED report on economic/workforce activities for and administration news and initiatives affecting economic and workforce development in the region. ARDOR executive directors and others are invited to participate.

The parties to this MOU agree to:

a) Participate in the Rural Economic Development Initiative (REDI) as requested;
b) Participate in REDI-related follow up, as requested.

7) **Vocational and Career Training.** For purposes of state agency input and coordination with the Denali Commission, the Alaska Human Resource Investment Council (AHRIC) is the recognized lead agency in vocational and career training. (SB 289) This agreement also recognizes that the Balance of State Workforce Investment Board sets policy and provides the state job training and employment resources through the one-stop system (ACJN). The Alaska Department of Education and Early Development has been tasked with developing a statewide comprehensive vocational education training strategy. The Denali Commission will continue to collaborate with AHRIC, the Alaska Department of Education and Early Development, other federal and state agencies and organizations in the design of the state's process to identify vocational and career training needs in high unemployment areas of Alaska, and deliver training to meet the workforce needs for the

foreseeable future. The State and the Denali Commission believe that a collaborative, coordinated approach to delivering needed training will be most effective and efficient.

The parties to this MOU agree to:

a) Where applicable and practicable, utilize the AHRIC process and the combined resources of all agencies including the Denali Commission; to identify needs and deliver training in high unemployment areas of Alaska.

Implementation:

1) This MOU becomes effective immediately for participating agencies upon signature and will remain in effect indefinitely.
2) Any party to this MOU may withdraw upon 30-day notice to all other participants. The MOU will remain in effect for all other participants so long as two or more remain.
3) Nothing in this MOU shall be construed to limit or modify the authority or responsibility of any participating agency.

This list will be an amendable document to allow for other agency participation.

9/26/00
Commissioner, Department of Administration

11/6/00
Commissioner, Department of Community and Economic Development

9/26/2000
Commissioner, Department of Education and Early Development

11/14/00
Commissioner, Department of Environmental Conversation

9/26/00
Commissioner, Department of Health and Social Services

Commissioner, Department of Law

Commissioner, Department of Labor and Workforce Development

Commissioner, Department of Military and Veterans Affairs

Commissioner, Department of Natural Resources

10/2/00
Commissioner, Department of Transportation and Public Facilities

President, University of Alaska

10/2/2000
State Co-Chair, Denali Commission

Dr. Sheila Selkregg
State Director
USDA-Rural Development

Bernhard Richert
Director
EDA

Colleen Bickford
State Director
US HUD

Niles Cesar
Regional Director
BIA

Patrick Poe
Regional Administrator
FAA

Marcia Combes
State Director
EPA

Christopher Mandregan, Jr., MPH
Director
IHS, Alaska Area Native Health
Service

For

Rick Cables
Regional Forester
USDA Forest Service

Colonel Steven Perrenot
District Engineer
U.S. Army Corps of Engineers

Jeff Staser
Federal Co-Chair
Denali Commission

Charles Becker
Director
Alaska Export Assistance Center
U.S. Commercial Service
United States Department of Commerce

Investment
Reports

STATE OF ALASKA
DEPARTMENT OF REVENUE
TREASURY DIVISION

Exxon Valdez Oil Spill Investment Fund

STATEMENT OF INVESTED ASSETS

June 30, 2001

Investments (at fair value)		2001
Cash and cash equivalents		
Short-term Fixed Income Pool	$	77,499
Marketable debt and equity securities		
Broad Market Fixed Income Pool		61,457,699
Non-retirement Domestic Equity Pool		49,293,870
SOA International Equity Pool		20,429,757
Total invested assets	$	131,258,825

STATE OF ALASKA
DEPARTMENT OF REVENUE
TREASURY DIVISION

Exxon Valdez Oil Spill Investment Fund

STATEMENT OF INVESTMENT INCOME
AND CHANGES IN INVESTED ASSETS

For the period ended June 30, 2001

	CURRENT MONTH	YEAR TO DATE
Investment Income		
Cash and cash equivalents		
Short-term Fixed Income Pool	$ 288	$ 94,825
Marketable debt and equity securities		
Non-pooled investments	0	61,799
Broad Market Fixed Income Pool	219,454	4,749,699
Non-retirement Domestic Equity Pool	(933,915)	(5,706,130)
SOA International Equity Pool	(698,305)	(2,570,243)
Total income from marketable debt and equity securities	(1,412,766)	(3,464,875)
Total investment income (loss)	(1,412,478)	(3,370,050)
Total invested assets, beginning of period	132,671,303	0
Net contributions (withdrawals)	0	134,628,875
Total invested assets, end of period	$ 131,258,825	$ 131,258,825

STATE OF ALASKA
DEPARTMENT OF REVENUE - TREASURY DIVISION

Exxon Valdez Oil Spill Investment Fund
Asset Allocation Policy (effective 4/24/00) with Actual Investment Holdings as of June 30, 2001

	Asset Allocation		Fair value	Current Allocation	Variance
	Policy	Range			
Cash and cash equivalents					
Short-term Fixed Income Pool	0.00%		77,211	0.06%	-0.06%
Total cash and cash equivalents	0.00%		77,211	0.06%	-0.06%
Marketable debt and equity securities					
Broad Market Fixed Income Pool	42.00%	35% - 49%	61,457,699	46.82%	-4.82%
Non-retirement Domestic Equity Pool	41.00%	34% - 48%	49,293,870	37.55%	3.45%
SOA International Equity Pool	17.00%	12% - 22%	20,429,757	15.56%	1.44%
Total marketable debt securities	100.00%		131,181,326	99.94%	0.06%
Total holdings	100.00%		131,258,536	100.00%	0.00%
Short-term Fixed Income Pool Interest Receivable			288		
Total Invested Assets at Fair Value			131,258,825		

Prepared by Treasury Division
Printed: 7/12/01 at 12:12 PM
Filename: EVOS_0601 policy

Exxon Valdez Oil Spill Investment Fund
Period Ending June 30, 2001

	Mkt Value ($M)	Monthly Return	3 Mo. Return	YTD	Fiscal YTD	Inception to Date*
AY02 EVOS Investment Fund	131,259	-1.06	2.62	-3.04	-	-4.28
EVOS Investment Fund Index		*-1.29*	*2.93*	*-3.43*	*-5.57*	*-5.10*
Short-term Fixed Income Pool	77	0.38	1.19	2.85	-	4.13
91 day T-Bill		*0.29*	*1.12*	*2.65*	*5.89*	*3.78*
Broad Market Fixed Income Pool	61,458	0.35	0.4	3.66	-	7.70
Lehman Brothers Aggregate Index		*0.38*	*0.56*	*3.60*	*11.23*	*7.26*
Non-Retirement Domestic Equity Pool	49,294	-1.86	6.87	-6.17	-	-13.34
Russell 3000 Index		*-1.84*	*6.88*	*-6.11*	*-13.93*	*-13.35*
SOA International Equity Pool	20,430	-3.31	-0.31	-12.99	-	-11.57
Morgan Stanley Capital Intl. (EAFE)		*-4.09*	*-1.05*	*-14.61*	*-23.61*	*-14.89*

Source: State Street Bank, Insight.

* Since October 31, 2000

Project 01535

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

MEMORANDUM

TO: Trustee Council

FROM: Molly McCammon
Executive Director

DATE: July 25, 2001

RE: Supplemental Funds for Project 01535, EVOS Trustee Council Final Report

Project 01535 included funds for eight months (October 2000 – May 2001) of Joe Hunt's time to prepare the EVOS Trustee Council Final Report. The original timeline called for a draft to be under review during the remainder of FY 01, and Joe to complete the report (following review) with FY 02 funds. However, the publisher (University of California Berkely Press) that we are negotiating with is asking us to submit the report to them in early September. In order to accommodate this, more of Joe's time is needed in FY 01.

The additional costs for Joe's time during the period July – September 2001 are estimated to be $16,000 for salary and benefits, and $2,400 for general administration costs, for a total of $18,400.

Project 01455, GEM and Research Program Data System, included funds for a data manager's salary, travel, and general administration which totaled $35,700. A portion of these funds will not be used during FY 01 because we are still developing the job qualifications.

<u>Executive Director's Recommendation</u>: Trustee Council approve the transfer of $18,400 from the Data Management Project (01455) budget to the Final Report Project (01535).

Office Move

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

MEMORANDUM

TO: Trustee Council

FROM: Molly McCammon
Executive Director

DATE: July 30, 2001

RE: Moving Budget

As most of you know, our current lease at 645 G Street expires in December 2001. The owner is not willing to extend the lease. Fortunately, we have been able to locate appropriate space downtown, close to a number of the Trustee agencies and the U.S. Department of Justice.

We are procuring the lease through the federal General Administration Services (GSA), with U.S. Geological Service as our sponsoring federal agency.

Detailed below are the costs associated with the office move, now scheduled for late September. We are doing our best to keep the costs to a minimum. However, the move is an opportunity to replace some worn out furniture items, such as conference room chairs, to upgrade our network operating speed, and to improve Internet access.

The new office space is larger than we need at this time. We are hoping to sub-lease some of the space to the North Pacific Research Board; if not, we will look for another tenant to sub-lease the extra space. Also, as we grow in the next five years (length of lease), we will have the space to accommodate new staff as needed.

Annual lease costs for our current space at 645 G Street have been $84,672, which is exceptionally low in today's market. Annual lease costs for our new space at 441 West 5th Avenue are $139,500 which is very reasonable in today's market. The increase in lease costs will be offset somewhat by sub-leasing a portion of the space. However, this does mean a $55,000 increase in annual lease costs. This is a significant increase, and without some subsidy from a sub-lease, makes it very difficult to keep within our overall administrative budget. For that reason, I have included the remaining lease costs (October 1 – December 31) for our current space in the moving budget. The FY 02 budget has 9 months of new lease costs plus interim utility costs and GSA fees for a total of $112,315. This still reflects a $27,643 increase from the FY 01 budget.

Description of Expense	Cost
Moving costs (furniture, equipment, files, etc)	10,000
De-installing and re-installing computer network system	1,600
Remaining lease costs on space that will be vacated by end of FY01	21,200
Furniture	40,000
Telephone set up	2,500
Computer cabling, computer rack with doors, phone & electrical wiring	11,000
Network switch/100mbs bandwidth	1,400
Internet access via State system with newer, faster T1 Line	3,000
Stationery & business cards	1,600
Sub-Total	92,300
GA	6,500
Total	98,800

Executive Director's Recommendation: Trustee Council approve $98,800 for the moving budget, with $37,600 for FY 01 and $61,200 for FY 02 (furniture and old lease).

Habitat Status

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

MEMORANDUM

TO: Trustee Council

FROM: Molly McCammon
Executive Director

RE: Habitat Program Update

DATE: July 26, 2001

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1. Small parcel and large parcel status reports are attached. The small parcel report has been reformatted to include the status of the $6.3 million designated by the Trustee Council for small parcels through 2002 (see Table 1).

   No action needed.

2. The Trustee Council's offers on the Duck Flats/Jack Bay package (PWS 05 $125,000, PWS 06 $100,000, PWS 1010 $1,130,000) expired June 21, 2001. The USFS is preparing a resolution to renew these offers. Negotiations for these parcels are nearly complete. Outstanding issues regarding the subsurface estate will be discussed by the USFS at the Council meeting.

   Executive Directors' Recommendation: Trustee Council renew offers on PWS 05, PWS 06, and PWS 1010.

3. The 13 Tatitlek homesites on which the Trustee Council made offers (5/22/00) have been purchased by Chugach Alaska Corporation. The USFS is assessing whether Chugach may be a willing seller or if there are other homesite owners who are willing sellers.

   Executive Director's Recommendation: Maintain designation of these funds ($180,000) for Tatitlek homesites at this time.

4. Of the $1 million designated by the Trustee Council for Kodiak 10-acre parcels, a small amount remains unallocated in each pot: $117,200 in the Larsen Bay Shareholder pot and $17,700 in the Kodiak Tax Parcel pot. The USFWS has requested that the Council approve combining these two amounts so that the remaining funds could be used for either Larsen Bay Shareholder or Kodiak Tax

parcels. This would increase USFWS flexibility in spending the funds and simplify record keeping for both the USFWS and the Restoration Office. [NOTE: "Unallocated" in this paragraph means purchase agreements have not been signed. The total amount approved by the Council for Kodiak 10-acre parcels was $1 million; the unallocated balance totals $134,900.]

Executive Director Recommendation: Trustee Council approve combining the funds remaining in the two Kodiak 10-acre designations, so that the funds can be spent on either Larsen Bay Shareholder parcels or Kodiak Tax parcels.

5. With the exception of the parcels noted above, all other acquisition efforts are proceeding and I am not recommending any other changes.

No action needed.

6. Trustee agency support costs for FY 02 are included in the discussion of the FY 02 Work Plan. In brief, I am recommending approval of $161,800. This consists of the specific costs estimate for each parcel that is actively being pursued (that is, the small parcels that comprise the $6.3 million designated by the Trustee Council through 2002 and continuation or completion of work on several large parcels previously approved by the Council).

No action needed at this time; will be included in motion on FY 02 Work Plan.

7. The pilot habitat protection grant with The Nature Conservancy and The Conservation Fund, approved by the Trustee Council in January 2001, has not been finalized. Several discussions among the USFWS (which will administer the grant), the state, and the Restoration Office have taken place, resulting in several revised drafts. We now seem to be very close to a final draft, which will then be reviewed by the two grantees before being signed and implemented.

No action needed at this time.

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

Habitat Protection Program:
Small Parcel Status Report

DRAFT July 26, 2001

The *Exxon Valdez* Oil Spill Trustee Council funds the acquisition of land to protect the habitat of resources and services injured by the spill. Since 1993, the Council has committed over $363 million to protect 643,635 acres of land. Most of the land is in large tracts (generally over 1,000 acres) that protect ecosystems and watersheds, but some is in smaller tracts (generally under 1,000 acres) with unique habitat or strategic value. This is a report on the status of the Small Parcel Habitat Protection Program.

	Acres Acquired	Cost
Large Parcels	635,770	$343.3 million
Small Parcels	7,865	$20.5 million
Total:	643,635	$363.8 million

Funds Available (Table 1). By resolution dated March 1, 1999, the Trustee Council has designated $6.3 million for small parcels through 2002, as outlined in Table 1. The Council has also designated $25 million for habitat protection beginning October 1, 2002, when spending from the Restoration Reserve will begin.

Outstanding Offers (Table 2). This table lists small parcels on which the Council has made purchase offers ($1.8 million to purchase 1,098 acres). All of these parcels are also listed in Table 1.

Parcels Under Consideration by the Council (Table 3). This table lists small parcels that the Council is considering acquiring (roughly 445 acres). The Council has authorized funding for appraisals, but has not authorized funding to purchase these parcels. All of these parcels are also listed in Table 1.

Acquisitions to Date (Table 4). This table lists small parcels that have been purchased with Trustee Council funds. To date, the Council has spent $20.5 million to purchase 7,865 acres of land in small parcels.

Table 1. Funds Available

Amount Designated for Small Parcel Acquisitions through 2002:	**$6,314,900**
Acquisitions completed	- 1,991,400
Support costs	- 866,600
Outstanding offers:	
Kodiak Tax / Larsen Bay Shareholder - 5 parcels	- 68,000
Tatitlek homesites - 13 parcels	- 180,000
PWS 05 / Valdez Duck Flats	- 125,000
PWS 06 / Valdez Duck Flats	- 100,000
PWS 1010 / Jack Bay	- 1,130,000
PWS 1028 / Valdez Duck Flats	- 120,000
KEN 294 / Elliot, Anchor River	- 78,000
Under consideration (costs are estimates only):	
KEN 309 / Icicle Seafoods, Ninilchik River	- 113,000
KEN 310 / Swartzes Enterprises, Ninilchik River	- 30,000
KAP 281 / Shugak (3 Saints Bay, KNWR)	- 110,500
KAP 283 / Metrokin (Chiniak Bay, AMNWR)	- 60,000
KAP 285 / Carlson (Hook Bay, APNWR)	- 120,000
Designated for additional Kodiak Tax / Larsen Bay parcels	- 134,900
Designated for Koniag large parcel acquisition ($0 if Uyak exchange goes through)	- 50,000
Designated for grant to non-profits	- 1,000,000
UNDESIGNATED BALANCE:	***$ 37,500***
Amount Designated for Habitat Protection Beginning October 2002:	**$25,000,000**

Table 2. Outstanding Offers

Parcel ID	Description	Acres	Value	Status
Purchase Agreements Signed		**50.0**	**$68,000**	
KAP 1098	LBS/C.F. (Amook Bay)	9.3	$14,000	
KAP 2000	LBS/C.F. (Amook Bay)	10.7	$15,000	
KAP 2019	LBS R. Christensen (Browns Lagoon)	10.0	$12,000	Certification letter sent 2/5/01.
KAP 2042	LBS D. Abston (Uyak Bay)	10.0	$15,000	
KAP 2069	LBS J. Johnson (Uyak Bay)	10.0	$12,000	
Offers Under Review by Landowners		**1,028.5**	**$1,655,000**	
PWS 05	Valdez Duck Flats	33.0	$125,000	Offer expired 6/21/01.
PWS 06	Valdez Duck Flats	25.0	$100,000	Offer expired 6/21/01.
PWS 296	Tatitlek Homesite (H. Olsen)	1.5	$13,000	Purchased by CAC.
PWS 297	Tatitlek Homesite (D. Totemoff)	1.5	$12,000	Purchased by CAC.
PWS 298	Tatitlek Homesite (J. Levshakoff)	1.5	$15,000	Purchased by CAC.
PWS 299	Tatitlek Homesite (L. Allen)	1.5	$16,000	Purchased by CAC.
PWS 300	Tatitlek Homesite (E. Barnes)	1.5	$14,000	Purchased by CAC.
PWS 301	Tatitlek Homesite (A. Elie)	1.5	$14,000	Purchased by CAC.
PWS 302	Tatitlek Homesite (L. Olsen)	1.5	$12,000	Purchased by CAC.
PWS 303	Tatitlek Homesite (S. Chernoff)	1.5	$14,000	Purchased by CAC.
PWS 304	Tatitlek Homesite (E. Gregorieff)	1.5	$14,000	Purchased by CAC.
PWS 305	Tatitlek Homesite (C. Totemoff)	1.5	$14,000	Purchased by CAC.
PWS 306	Tatitlek Homesite (D. Wilfer)	1.5	$16,000	Purchased by CAC.
PWS 307	Tatitlek Homesite (J. Totemoff)	1.5	$13,000	Purchased by CAC.
PWS 308	Tatitlek Homesite (P. Totemoff)	1.5	$13,000	Purchased by CAC.

PWS 1010	Jack Bay	942.0	$1,130,000	Offer expired 6/21/01.
PWS 1028	Valdez Duck Flats (USS 349)	9.0	$120,000	Offer expires 9/1/01.
KEN 294	Eliot (Anchor River)	19.8	$78,000	Offer expires 9/1/02.
	TOTAL:	***1,088.3***	***$1,801,000***	

Table 3. Parcels Under Consideration by the Council

Parcel ID	Description	Acres	Comments
KEN 293	Yager (Anchor River)	9.7	Landowner opted out of process.
KEN 295	Brookwood (Anchor River)	60.0	Landowner rejected offer.
KEN 309	Icicle Seafoods (Ninilchik River)	4.2	Appraisal authorized 7/5/00.
KEN 310	Swartzes Enterprises (Ninilchik River)	0.2	Appraisal authorized 7/5/00.
KAP 281	Shugak (3 Saints Bay, KNWR)	100.3	Appraisal authorized 7/5/00.
KAP 283	Metrokin (Chiniak Bay, AMNWR)	110.3	Appraisal authorized 7/5/00.
KAP 285	Carlson (Hook Bay, APNWR)	160.0	Appraisal authorized 7/5/00.
Larsen Bay Shareholder Parcels			Original authorization was $645,000; remaining balance is $117,200.
Kodiak Island Borough Tax Parcels			Original authorization was $355,000; remaining balance is $17,700 (NOTE: $50,000 went to Koniag large parcel deal and $2,300 went to Morris parcel.).
	TOTAL	***444.7***	

NOTE: KAP 150 (Karluk River weir site, 5 ac.) is being considered as part of a large parcel acquisition from the Karluk Village IRA Council. See Large Parcel Status Report for more information.

Table 4. Acquisitions to Date

Parcel ID	Description	Acres	Cost	Comments
Prince William Sound (PWS)		**449.9**	**$1,907,300**	
PWS 11	Horseshoe Bay (Chenega)	315.0	$475,000	
PWS 17, 17A-D	Ellamar Subdivision (Tatitlek)	33.4	$655,500	
PWS 52	Hayward (Valdez)	9.5	$150,000	
PWS 1056	Blondeau (Valdez)	92.0	$626,800	
Kenai Peninsula (KEN)		**5,725.4**	**$15,896,100**	
KEN 10	Kobylarz Subdivision (Kenai River)	20.0	$320,000	
KEN 19	Coal Creek Moorage (Kasilof R.)	53.0	$260,000	
KEN 29	Tulin (Homer)	220.0	$1,200,000	
KEN 34	Cone (Kenai River)	100.0	$600,000	
KEN 54	Salamatof (Kenai River)	1,377.0	$2,540,000	
KEN 55	Overlook Park (Homer)	97.0	$279,000	
KEN 148	River Ranch (Kenai River)	146.0	$1,650,000	
KEN 1002/03/04	Stephanka/Moose R. (KNA Pkg.)	3,254.0	$4,000,000	454 of these acres purchased with $443,000 in federal restitution funds.
KEN 1005	Ninilchik (Ninilchik State Rec Area)	16.0	$50,000	
KEN 1006	Girves (Kenai River)	110.0	$1,835,000	
KEN 1014	Grouse Lake (Seward)	64.0	$211,000	

KEN 1015	Lowell Point (Seward)	19.4	$531,000	
KEN 1034	Patson (Kenai River)	76.3	$450,000	
KEN 1038	Roberts (Kenai River)	3.3	$698,000	
KEN 1049	Mansholt (Kenai River)	1.6	$55,000	
KEN 1051	Salamatof (Kenai River)	14.5	$149,500	
KEN 1052	Salamatof (Kenai River)	6.6	$33,500	
KEN 1060A-D	Mud Bay (Homer Spit)	68.7	$422,100	
KEN 1061	Beluga Slough (Homer Spit)	38.0	$574,000	City of Homer added $41,000.
KEN 1084	Morris (Ninilchik River)	40.0	$38,000	Includes $2.3 from KIB tax pot.
Kodiak/Alaska Peninsula (KAP)		**1,689.9**	**$2,661,300**	
KAP 91	Adonga (Sitkalidak Strait)	137.0	$137,000	Native Allotment
KAP 95	Inga (Three Saints Bay)	80.0	$84,000	
KAP 98	Pestrikoff (Kiliuda Bay)	80.0	$128,000	Native Allotment
KAP 99	Shugak (Kiliuda Bay)	160.0	$155,200	Native Allotment
KAP 101	Haakanson (Sitkalidak Strait)	80.0	$52,000	Native Allotment
KAP 103	Kahutak (Sitkalidak Strait)	40.0	$66,000	Native Allotment
KAP 105/142	Pestrikoff/Kelly (Three Saints Bay)	88.0	$168,000	Native Allotment
KAP 114	J. Johnson (Uyak Bay)	55.0	$154,000	Native Allotment
KAP 115	J. Johnson (Uyak Bay)	65.0	$110,500	Native Allotment
KAP 126	C. Christiansen (Three Saints Bay)	40.0	$72,000	
KAP 131	Matfay (Kiliuda Bay)	40.0	$68,000	Native Allotment
KAP 132	Peterson (Sitkalidak Strait)	160.0	$256,000	Native Allotment
KAP 134	Ignatin (Three Saints Bay)	80.0	$72,300	Native Allotment
KAP 135	Capjohn (Kiliuda Bay)	70.0	$73,500	Native Allotment
KAP 220	Mouth of Ayakulik River	5.4	$80,000	
KAP 226	Karluk River Lagoon	16.3	$240,000	
KAP 1089	LBS R. Christensen (Amook Bay)	8.1	$13,000	
KAP 1090	LBS D. Naumoff (Amook Bay)	7.7	$16,000	
KAP 1091	LBS D. Easter (Amook Bay)	10.4	$18,000	
KAP 1092	LBS/C.F. (Amook Pass)	9.7	$12,000	
KAP 1093	LBS/C.F. (Brown Lagoon)	10.0	$12,000	
KAP 1094	LBS/C.F. (Brown Lagoon)	13.2	$15,000	
KAP 1095	LBS/C.F. (Brown Lagoon)	8.9	$18,000	
KAP 1096	LBS/C.F (Amook Bay)	10.0	$11,000	
KAP 1097	LBS/C.F. (Amook Bay)	11.0	$15,000	
KAP 1099	LBS/C.F. (Amook Bay)	9.1	$15,000	
KAP 2001	LBS/C.F. (Uyak Bay)	10.4	$20,000	
KAP 2002	LBS/C.F. (Uyak Bay)	8.3	$15,000	
KAP 2003	LBS/C.F. (Uyak Bay)	9.7	$16,000	
KAP 2004	LBS/C.F. (Uyak Bay)	7.0	$15,000	
KAP 2005	LBS/C.F. (Uyak Bay)	6.9	$17,000	
KAP 2006	LBS/C.F. (Uyak Bay)	8.5	$13,000	
KAP 2007	LBS/C.F. (Uyak Bay)	12.3	$14,000	
KAP 2009	KIB Tax Parcel (Zachar Bay)	9.9	$16,000	
KAP 2010	KIB Tax Parcel (Zachar Bay)	4.7	$16,000	
KAP 2011	KIB Tax Parcel (Amook Pass)	13.4	$18,000	
KAP 2012	KIB Tax Parcel (Browns Lagoon)	10.0	$9,000	
KAP 2013	KIB Tax Parcel (Amook Pass)	10.0	$18,000	
KAP 2014	KIB (Amook Pass)	10.4	$19,000	
KAP 2015	KIB Tax Parcel (Amook Pass)	11.1	$12,000	
KAP 2016	KIB (South Uyak Bay)	6.0	$18,000	

KAP 2017	KIB Tax Parcel (S. Uyak Bay)	7.9	$18,000
KAP 2024	LBS/C.F. (Uyak Bay)	8.6	$16,000
KAP 2036	LBS J. Penkusky (Carlsen Point)	10.0	$22,000
KAP 2038	LBS G. Johnson (Uyak Bay)	10.0	$18,000
KAP 2039	LBS R. Penwarden (Uyak Bay)	10.0	$18,000
KAP 2040	LBS P. Abston (Uyak Bay)	10.0	$11,000
KAP 2044	LBS J. Antonsen (Larsen Bay)	10.0	$22,800
KAP 2045	LBS J. Antonsen (Larsen Bay)	10.0	Included in KAP 2044
KAP 2046	LBS V. Abston (Uyak Bay)	10.0	$15,000
KAP 2048	KIB Tax Parcel (Uyak Bay)	10.0	$12,000
KAP 2049	KIB Tax Parcel (Uyak Bay)	10.0	$12,000
KAP 2050	KIB Tax Parcel (Uyak Bay)	10.0	$11,000
KAP 2052	KIB Tax Parcel (Carlsen Point)	10.0	$15,000
KAP 2053	KIB Tax Parcel (Carlsen Point)	10.0	$9,000
KAP 2054	KIB Tax Parcel (Carlsen Point)	10.0	$9,000
KAP 2055	KIB Tax Parcel (Zachar Bay)	10.0	$18,000
KAP 2056	KIB Tax Parcel (Larsen Bay)	10.0	$12,000
KAP 2057	KIB Tax Parcel (Larsen Bay)	10.0	$14,000
KAP 2058	KIB Tax Parcel (Larsen Bay)	10.0	$17,000
KAP 2059	KIB Tax Parcel (Larsen Bay)	10.0	$12,000
KAP 2063	LBS J. Johnson (Larsen Bay)	10.0	$10,500
KAP 2064	LBS N. Johnson (Larsen Bay)	10.0	$10,500
KAP 2065	LBS P. Hester (Amook Pass)	10.0	$13,500
KAP 2066	LBS J. Johnson (Larsen Bay)	10.0	$11,500
KAP 2067	LBS J. Wicks (Zachar Bay)	10.0	$18,000
KAP 2068	LBS J. Wicks (Zachar Bay)	10.0	$18,000
	TOTAL:	***7,865.2***	***$20,464,700***

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

Habitat Protection Program: Large Parcel Status Report

DRAFT July 26, 2001

The *Exxon Valdez* Oil Spill Trustee Council funds the acquisition of land to protect the habitat of resources and services injured by the spill. Since 1993, the Council has committed $363.7 million to protect 643,585 acres of land. Most of the land is in large tracts that protect larger ecosystems and watersheds, but some is in smaller tracts with unique habitat or strategic value. This is a report on the status of the Large Parcel Habitat Protection Program.

	Acres Acquired	Cost
Large Parcels	635,770	$343.3 million
Small Parcels	7,815	$20.4 million
Total:	643,585	$363.7 million

Large Parcel Acquisitions (Table 1). The Council has committed $343.3 million to protect 635,770 acres of land in large parcels, including inholdings in Kachemak Bay State Park, land on Afognak Island, commercial timber rights on land along Orca Narrows, a parcel on Shuyak Island, and lands formerly owned by Afognak Joint Venture, Akhiok-Kaguyak, Inc., Old Harbor Native Corporation, Koniag, Inc., Chenega Corporation, English Bay Corporation, Tatitlek Corporation and Eyak Corporation.

Large Parcel Offers (Table 2). In January 2001 the Council offered $29.95 million to Koniag, Inc. to extend the limited-term nondevelopment easement on 55,402 acres along the Karluk and Sturgeon rivers. The easement is slated to expire in 2001. The Council's offer to extend the easement another ten years has been approved by the Koniag Board of Directors, and final closing documents are being prepared. (The Council's contribution to the easement would be reduced by $100,000 if a proposed exchange of lands in the Uyak area goes through.)

Payment Schedules (Table 3). Payment for the Eyak and Shuyak Island parcels are being made in installments. About $58.3 million has already been paid for these parcels. An additional $28.8 million is due on these parcels and will be paid in installments by October 2002. Payment schedules are shown in Table 3.

Additional Protection Possibilities. In March 2000, the Trustee Council authorized appraisal of approximately 1,850 acres of lands owned by the Karluk Village IRA Council. An appraisal has been completed. The landowner is now considering what type of protection/acquisition package they could support.

Negotiations Halted. Port Graham Corporation has officially withdrawn from any further negotiations at this time.

Table 1. Large Parcel Acquisitions

Parcel Acquired	Acreage	Total Price (Incl. Interest)	Trust Fund	Other Sources[1]
Afognak Joint Venture (AJV)	41,750	$74,023,342	$74,023,342	$0
Akhiok - Kaguyak, Inc.	115,973	$46,000,000	$36,000,000	$10,000,000
Chenega	59,520	$34,000,000	$24,000,000	$10,000,000
English Bay[2]	32,537	$15,371,420	$14,128,074	$1,243,346
Eyak	75,425	$45,129,854	$45,129,854	$0
Kachemak Bay State Park Inholdings	23,800	$22,000,000	$7,500,000	$14,500,000
Koniag (easement to 12/15/01)	55,402	$2,000,000	$2,000,000	$0
Koniag (fee title)	59,674	$26,500,000	$19,500,000	$7,000,000
Old Harbor[3]	31,609	$14,500,000	$11,250,000	$3,250,000
Orca Narrows (timber rights)	2,052	$3,450,000	$3,450,000	$0
Seal Bay / Tonki Cape	41,549	$39,549,333	$39,549,333	$0
Shuyak Island	26,665	$42,000,000	$42,000,000	$0
Tatitlek	69,814	$34,719,461	$24,719,461	$10,000,000
TOTAL:	***635,770***	***$399,243,410***	***$343,250,065***	***$55,993,346***

Table 2. Large Parcel Offers[4]

Parcel	Acreage	Total Offer (plus interest)	Trust Fund	Other Sources
Koniag (easement 12/15/01-10/15/02)	(above)	$300,000	$150,000	$150,000
Koniag (easement 10/15/02- on)	(above)	$29,800,000	$29,800,000	$0
TOTAL:		***$30,100,000***	***$29,950,000***	***$150,000***

Table 3. Payment Schedules

	AJV	Eyak	Shuyak	Total
Amount Paid	$74,023,342	$32,129,854	$26,194,266	**$132,347,462**
Remaining Commitment				
Sept. 2001	$0	$6,000,000	$0	**$6,000,000**
Oct. 2001	$0	$0	$4,000,000	**$4,000,000**
Sept. 2002	$0	$7,000,000	$0	**$7,000,000**
Oct. 2002	$0	$0	$11,805,734	**$11,805,734**
TOTAL:	***$74,023,342***	***$45,129,854***	***$42,000,000***	***$161,153,196***

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[1] For Kachemak Bay State Park inholdings, other funding is a State of Alaska contribution of $7 million from the Exxon plea agreement and $7.5 million from the civil settlement with the Alyeska Pipeline Service Company. For all other parcels, funding from other sources consists of a Federal contribution from the Exxon plea agreement.

[2] The Trustee Council's contribution to the English Bay acquisition consisted of a single payment to the federal government. The federal government's first closing on English Bay occurred in November 1997. Subsequent closings will occur through October 2002 to complete the acquisition.

[3] As part of the protection package, the Old Harbor Native Corporation agreed to protect an additional 65,000 acres of land on Sitkalidak Island as a private wildlife refuge.

[4] The costs shown for the Koniag easement assume no exchange of Uyak lands. If the exchange goes forward, the Trustee Council's contribution to the 12/15/01-10/15/02 easement would increase to $300,000 and their contribution to the 10/15/02-on easement would decrease to $29,550,000, for an overall savings of $100,000.

Large Parcel Acquisitions

Afognak Joint Venture. In November 1998, Afognak Joint Venture transferred to the state and federal governments.surface title to about 41,350 acres of land on northern Afognak Island and easements on an additional 400 acres. Surface title was acquired in parcels adjacent to Shuyak Strait, adjacent to the Kodiak Island National Wildlife Refuge, east of Pauls and Laura Lakes, and adjacent to Tonki Bay, and several islands in Perenosa Bay and Blue Fox Bay. Afognak Joint Venture retained timber rights for 15 years in about 2,213 acres acquired to the east of Pauls and Laura Lakes. The acquisition included a conservation easement preserving a 200-foot buffer along the western shores of Pauls and Laura Lakes and easements for the operation of weir sites on the eastern shore of Waterfall Creek and at the mouth of Pauls Creek. The total purchase price was $74 million.

Akhiok-Kaguyak. In May 1995, the federal government agreed to purchase from Akhiok-Kaguyak, Inc., surface title to 73,525 acres of land and conservation easements on 42,448 acres, for a total of 115,973 acres. These lands are within the Kodiak National Wildlife Refuge. The Council contributed $36 million to this acquisition and the federal government contributed $10 million from the federal restitution fund, for a total purchase price of $46 million.

Chenega. In June 1997, the Chenega Corporation transferred to the U.S. Forest Service surface title to 20,968 acres of land and a conservation easement on an additional 22,284 acres. The corporation also transferred to the State of Alaska surface title to 16,268 acres of land in Prince William Sound. The total acreage to be protected is 59,520. Public access is allowed on all the land in the conservation easement except 3,330 acres on the southern portion of Chenega Island in the vicinity of the original Chenega village site. Two parcels acquired in fee simple, the Eshamy Bay and Jackpot Bay parcels, are among the highest ranked parcels in the oil spill area. The Trustee Council contributed $24 million to this acquisition and the federal government contributed an additional $10 million from the federal restitution fund, for a total purchase price of $34 million.

English Bay. In February 1997, the Trustee Council authorized funds for the purchase from the English Bay Corporation of land within the Kenai Fjords National Park and the Alaska Maritime National Wildlife Refuge. Surface title to 32,537 acres of land is being acquired for $15.37 million. Certain access rights for hunting, fishing and gathering activities will be reserved and retained by the English Bay Corporation. The Trustee Council has contributed $14.13 million to this acquisition and the federal trustees have agreed to provide up to $1.24 million from federal criminal restitution funds to complete the acquisition. The English Bay Corporation will commit $500,000 from its proceeds to establish a special cultural conservation fund to survey, protect, curate and interpret archaeological sites and cultural artifacts which are associated with the lands acquired.

The Council's contribution to the English Bay acquisition consisted of a single payment to the federal government. The federal government's first closing on English Bay occurred in November 1997. Subsequent closings will occur through October 2002 to complete the acquisition.

Eyak. In July 1997, the Trustee Council authorized $45 million to purchase 75,425 acres from The Eyak Corporation. The agreement includes surface title to 55,357 acres of land in eastern Prince William Sound, conservation easements on an additional 6,667 acres and timber easements on 13,401 acres. This acquisition protects habitat in the wooded shoreline areas of Nelson Bay, Eyak Lake and Hawkins Island, much of it visible from the City of Cordova. The package also includes Port Gravina, Sheep Bay and Windy Bay, which are considered among the most valuable parcels in Prince William Sound for recovery of species injured by the spill. Most of the land will be administered as part of the Chugach National Forest. One small tract will be managed by the State as part of the existing Canoe Passage State Marine Park. The total purchase price of $45.1 million is being distributed in a series of payments to the landowner; the final payment is scheduled to occur in September 2002.

Kachemak Bay. In August 1993, the state acquired surface title to 23,800 acres of private inholdings within Kachemak Bay State Park on the Kenai Peninsula. This acquisition protects a highly productive estuary, several miles of anadromous fish streams and intertidal shoreline and upland habitat for bald eagles, marbled murrelets, river otters, and harlequin ducks. The Trustee Council contributed $7.5 million to this purchase and the State of Alaska contributed $7.0 million from the Exxon plea agreement and $7.5 million from the civil settlement with Alyeska Pipeline Service Company.

Koniag. In November 1995, the federal government agreed to purchase from Koniag, Inc., surface title to 59,674 acres of prime habitat for bear, salmon, bald eagles, and other species in the Kodiak National Wildlife Refuge. The Trustee Council contributed $19.5 million to the acquisition of fee title and the federal government contributed $7.0 million from the federal restitution fund, for a total purchase price of $26.5 million. The 1995 agreement also protected an additional 55,402 acres along the Karluk and Sturgeon rivers under a nondevelopment easement that will expire December 15, 2001. The Council paid an additional $2.0 million for the original nondevelopment easement. On January 16, 2001 the Council approved $29.95 million to extend the easement (with the addition of Camp Island) at least ten years, with an additional $150,000 to come from U.S. Department of Interior criminal funds. The Koniag Board of Directors has accepted the Council's offer and final closing documents are being prepared. The terms of the agreement include establishment of a fund that might be tapped for acquisition at Koniag's sole discretion at some date in the future. (NOTE: If a particular exchange of lands in the Uyak area occurs between DOI and Koniag, the Council's contribution to extension of the easement will be reduced to $29.85 million.)

Old Harbor. In 1995, the federal government agreed to purchase from the Old Harbor Native Corporation surface title to 28,609 acres of land and the corporation donated a conservation easement on 3,000 acres. These lands are within the Kodiak National Wildlife Refuge. In addition, the Old Harbor Native Corporation agreed to preserve 65,000 acres of land on nearby Sitkalidak Island as a private wildlife refuge. The Trustee Council contributed $11.25 million to this acquisition and the federal government contributed $3.25 million from the federal restitution fund, for a total purchase price of $14.5 million.

Orca Narrows Subparcel. In January 1995, the federal government purchased from the Eyak Corporation commercial timber rights on 2,052 acres of land in Orca Narrows. This parcel is near Cordova in Prince William Sound and contains anadromous fish streams, active bald eagle nests and favorable habitat for marbled murrelet nesting. The Trustee Council paid $3.45 million for this acquisition.

Seal Bay and Tonki Cape (Afognak Island). In November 1993, the state purchased surface title to 41,549 acres on northern Afognak Island. This mature spruce forest is adjacent to highly productive marine waters, includes anadromous fish streams, and provides excellent habitat for bald eagles and marbled murrelet nesting. The Trustee Council contributed $39.5 million (including interest) to this acquisition. In 1994, the Alaska State Legislature designated these lands as the Afognak Island State Park.

Shuyak Island. In March 1996, the state purchased from the Kodiak Island Borough surface title to 26,665 acres of prime habitat on Shuyak Island, at the northern tip of the Kodiak archipelago. The purchase price was $42 million to be paid over seven years, with the final payment scheduled to occur in October 2002. The Kodiak Island Borough agreed to commit $6 million from the land sale to expansion of Kodiak's Fishery Industrial Technology Center.

The resolution providing funds for acquisition of lands on Shuyak Island also authorized up to $1 million to purchase small waterfront lots forfeited to the Kodiak Island Borough because of tax delinquency. As a result of the 1980 merger of the former Larsen Bay village corporation with Koniag, Inc., the Larsen Bay Tribal Council received about 2,000 acres of land to be distributed among the shareholders of record. About 10 acres in size, these parcels occupy key waterfront locations along Uyak Bay within the boundaries of land purchased from Koniag, Inc. Kodiak Island Borough acquired some of these lots as a result of forfeitures for tax delinquencies; the rest are held by Larsen Bay shareholders. In June 1998, the Council allocated $355,000 of the earmarked funds for the purchase of forfeited tax parcels and $645,000 for the purchase of parcels owned by Larsen Bay shareholders (see Small Parcel Status Report for further detail).

Tatitlek. In June and October 1998, Tatitlek Corporation transferred to the state and federal governments surface title to 32,284 acres of land and conservation easements on 37,530 acres. The total acreage protected is 69,814. Two of the parcels acquired, Bligh Island and Two Moon Bay, were the third and fourth highest ranked parcels in Prince William Sound. The acquisition includes timber-only conservation easements on the north shore of Port Fidalgo and on land at Sunny Bay. The Trustee Council contributed $24.7 million to this acquisition and the federal government contributed an additional $10 million from the federal restitution fund, for a total purchase price of $34.7 million.

The resolution providing funds for acquisition of lands from Tatitlek Corporation also designated homesite lots in the Two Moon Bay and Snug Corner Cove subdivisions as parcels meriting special consideration under the Trustee Council's small parcel process. If the United States or the State of Alaska acquires any block of six or more of these homesite lots from willing sellers, the Tatitlek Corporation will convey, at no cost, the surface fee estate to the acreage immediately behind the block of homesite lots.

Additional Protection Possibilities

Karluk. On March 16, 2000, the Trustee Council authorized the Alaska Department of Natural Resources to move forward with an appraisal, hazardous materials survey, and title search of approximately 1,850 acres owned by the Karluk Village IRA Council. The appraisal, which was completed and approved in February 2001, is $2.2 million for a total of 2,191 acres. This consists of 1,008 acres within the Karluk River drainage (including the 5-acre Karluk weir site which was first evaluated as KAP 150 in 1994) and 1,183 acres within the Kodiak National Wildlife Refuge around Sturgeon, Grant, and Halibut lagoons (these lands are within large parcels -- KON 05 and KON 06 -- that were previously evaluated). The landowner is now considering what type of protection/acquisition package they could support.

Negotiations Halted

Port Graham. As indicated in a letter from board president Pat Norman, the Port Graham Corporation has withdrawn from any further negotiations with the U.S. Department of the Interior for purchase of 46,170 acres. Most of this land is within the Kenai Fjords National Park.

UA Parcels

RESOLUTION WILL BE FORTHCOMING

GEM Writing
Contract

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

MEMORANDUM

TO: Trustee Council

FROM: Molly McCammon
Executive Director

RE: Supplemental Funds for Project 01630 / Planning for GEM

DATE: July 26, 2001

Project 01630 included funding for contract writers to draft the Scientific Background chapter of the GEM program document. This chapter provides the essential scientific basis for the long-term research and monitoring plan. The use of contract writers proved to be a highly effective technique for ensuring that this chapter includes a current and thorough description of the scientific understanding of the Gulf of Alaska.

Human use is currently described in Chapter 2 of the GEM draft. However, as our work on the draft has continued, we have concluded that a full presentation of the current state of knowledge about human activities and human impacts should be a section of the Scientific Background chapter. We estimate that a contract to research and write this section will cost about $15,000. Only about $5,000 of the existing Project 01630 allocation is available for reprogramming to this purpose.

Unspent funds are available within Project 01455/GEM Data System due to a delay in the hiring of a GEM data manager (originally anticipated for late in FY 01; now expected early in FY 02).

<u>Executive Director's Recommendation:</u> Trustee Council approve the transfer of $10,700 from Project 01455/GEM Data System to Project 01630/Planning for GEM for the purpose of contracting for preparation of a human uses section for the GEM document.

[NOTE: $10,000 would be for the contract itself; $700 would be for ADNR general administration costs).

PAG Report

Meeting Summary

A. GROUP: *Exxon Valdez* Oil Spill Public Advisory Group (PAG)

B. DATE/TIME: July 18, 2001

C. LOCATION: Anchorage, Alaska

D. MEMBERS IN ATTENDANCE:

Name	Principal Interest
Torie Baker	Commercial Fishing
Chris Beck	Public-at-Large
Gary Fandrei	Public-at-Large
Brett Huber	Sport Hunting & Fishing
Dan Hull	Public-at-Large
James King	Conservation
Chuck Meacham, Chair	Science/Academic
Pat Norman	Native Landowner
Stan Senner	Environmental
Ed Zeine	Local Government

E. NOT REPRESENTED:

Name	Principal Interest
Chris Blackburn	Public-at-Large
Dave Cobb	Public-at-Large
Bud Perrine	Aquaculture
Gerry Sanger	Commercial Tourism
Stacy Studebaker	Recreation Users
Chuck Totemoff	Forest Products
Martha Vlasoff	Subsistence
John Harris	Alaska State House of Representatives (*ex officio*)
Loren Leman	Alaska State Senate (*ex officio*)

F. OTHER PARTICIPANTS:

Name	Organization
Patty Brown-Schwalenburg	Chugach Regional Resources Commission
Barat La Porte	Patton Boggs
Molly McCammon	Trustee Council Staff
Phil Mundy	Trustee Council Staff
Doug Mutter	Designated Federal Official, Dept. of the Interior
Cynthia Brady	Dept. of the Interior
Chip Demarest	Dept. of the Interior
Sandra Schubert	Trustee Council Staff
Veronica Christman	Trustee Council Staff

Cherri Womac	Trustee Council Staff
Bill Hauser	Alaska Department of Fish and Game
Jeff Short (via telecon)	National Oceanic and Atmospheric Administration
John Hall	Taiga Resource Consultants
Gordon Robilliard	

G. SUMMARY:

The meeting was convened July 18 at 8:40 a.m. by Chuck Meacham. Roll call was taken, a quorum was present. The April 4, 2001, meeting summary was approved.

Molly McCammon provided a status report on current Trustee Council activities. A report to Congress is being prepared (due September 30, 2001) describing the Trustee Council's plans for future administration and management of *Exxon Valdez* Oil Spill (EVOS) funds. This report was required by the legislation enabling transfer of EVOS trust funds from the Federal Treasury. She noted that the current make-up of the Council would probably continue until at least 2006, during which time the EVOS litigation remains open.

McCammon reported that collaboration agreements were being pursued with other research fund organizations, such as the North Pacific Research Board (NPRB) and the Pacific Salmon Treaty. The Denali Commission has a model agreement they are looking at.

The Trustee Council offices are moving in September to the Chamber of Commerce building in Anchorage. The current lease is up and the new building owners are moving in, thus necessitating the move. The NPRB may co-locate with the Trustee Council.

She discussed the status of trust fund investments (mailed to PAG members). The status of investments can be found on the Alaska Department of Revenue web site. At a recent conference on foundations she learned that the average payout of monies from trust funds was 5%. The Trustee Council plans a 4-1/2% payout.

McCammon discussed the Habitat Protection program (information mailed to PAG members). Final payments on some of the large parcels will be occurring until 2002. The Karluk River project with Koniag is yet to be signed. Some 7,865 acres in small parcels have been (mostly) purchased. It is not clear what will happen to the remaining small parcel funds if not all the purchases on the table are made. The trial pilot project with the Alaska Conservation Foundation and The Nature Conservancy is still not signed, but should be shortly.

Jeff Short reported on the lingering oil project. Three-fourths of the over 8,000 pits at 96 sites have been dug and the project is on schedule. The purpose is to quantify the beaches with remaining oil contamination and estimate the amount of remaining oil. They are focused on the most heavily oiled areas of Prince William Sound. Random samples are taken in the immediate tidal zone and just above the tide line. Ten percent of the pits dug had oil. Of those, 6% had subsurface oil (similar to the original crude) and 4% had surface oil (hardened)–and usually not both. The oil seemed to extend to the low intertidal zone. This is more oil than they expected to find. Mobilization is probably low, with only localized impacts. Additional analyses will be made.

Veronica Christman updated the group on the archeology project. In 1999 $2.8 million was awarded to Chugachmuit to develop a regional repository, local display capabilities in eight communities, and traveling exhibits for EVOS artifacts recovered in the Prince William Sound and Cook Inlet areas. The repository in Seward is set to open in March 2002. The local display capabilities are in various stages of proposal, design and construction and should be completed by the end of 2003. The traveling exhibit plan and design is expected in 2002.

Cherri Womac briefed the group on revised State travel rules and procedures (see handouts). Contact her if there are questions about PAG member travel.

McCammon summarized the July 17, 2001, PAG Gulf Ecosystem Research and Monitoring Program (GEM) workshop session. The group generally agreed that one "program advisory committee" with expanded public, community, and scientific representation was preferable to several advisory committees. Some details were discussed but no consensus reached. The role of additional science advisors should be peer review, not a separate formal committee, and the PAG suggested there be no separate community advisory committee. The chief scientist function should be in one person, on staff. A mix of paid and volunteer peer review was deemed most practical. Data and information management is very important and more than one staff person will likely be required. More flexibility is needed now for deciding the importance of the question of "normal agency management" versus "work caused by the spill."

McCammon noted that the GEM document (Review Draft July 6, 2001 version) is still a rough draft. There will be a meeting next week with agency representatives to discuss the draft and the Trustee Council will meet August 6 to review it. The goal is to have a draft document to the National Research Council (NRC) by mid-September, when they meet in Seattle. The GEM document is available on the EVOS web site at: www.oilspill.state.ak.us. An Executive Summary will be written soon.

McCammon and Phil Mundy briefly went through the GEM document chapter-by-chapter. Dan Hull stated that (in Chapter 1) the program short-term benefits should not be undersold and he questioned how GEM would be institutionalized within natural resource management agencies. Pat Norman stated that results needed to be related to the management of resources. In discussing Chapter 3, Meacham said that they need to include considerations from the recent lingering oil project. Stan Senner said more references were needed. McCammon noted that Chapter 5 was long and may become an appendix with a summary of it substituted as the chapter. Senner stated that, in Chapter 6, the central hypothesis is less useful than the questions in section 6.2. Norman wondered (in Chapter 9) how the GAP analysis could relate to making better resource harvest decisions. Chris Beck suggested they be more specific about strategies to obtain application of the research. Senner recommended showing managers how they can benefit. Mundy suggested reading Chapter 10 to get a flavor for the GEM concept. There was general agreement that the document was complex and that a simple summary version was required.

The session was opened for public comment. Patty Brown-Schwalenburg commented about the EVOS community involvement program. She noted that communities were compiling a list of priority injured species, five pilot projects for tribal natural resource plans were in process, long-term stewardship of resources was being discussed with communities, a guide for preparing village natural resource programs will be developed, a region-wide natural resources plan is being completed, and a paper concerning the proposed $20 million community fund is being revised. When asked about the NRC's proposed GEM committee structure, she replied that they believed one committee was better to encourage interaction. She also noted that community facilitators were not getting enough money to make the program worthwhile. A separate community fund could help keep staff and offices operational in communities.

McCammon noted that the over $10 million in proposals was received to address a budget cap of $6.5 million for the FY 2002 Work Plan (draft mailed to PAG members). The clusters of projects have been revised to be more in keeping with the GEM concept. She and Mundy reviewed the clusters following Spreadsheet A, Executive Director's Preliminary Recommendations. PAG members had questions on these projects:

> Sea ducks–Norman questioned whether harlequin ducks and scoters are safe to eat given that they feed in the intertidal zone where residual oil is being found.
>
> Ships of opportunity–Hull suggested that this be done in Prince William Sound as well.
>
> Herring projects–Hull and Torie Baker stated that herring were important in the ecosystem and felt more herring projects should be undertaken. Mundy responded (see handout) that not all areas needing research received proposals. McCammon said they would have a teleconference with Fish and Game and Chief Scientist, Bob Spies, to further discuss this issue. Hull, Baker and Meacham said they would like to participate.
>
> Pink salmon–Hull questioned what work would be done in place of dropped pristane projects. Mundy responded that other variables needed examining before returning to pristane studies.
>
> Sockeye salmon–Norman asked that sockeye salmon lakes on the southern Kenai peninsula be added to project 02649. Mundy said that if this project had successful results, and if the proposed lakes met the study criteria, they might be added later (he will discuss with the Principal Investigator).

McCammon said that this winter a review of injury and recovery objectives would take place. The annual EVOS symposium will be held in January 2002.

The group discussed the possibility of a PAG field trip next year.

The meeting adjourned at 3:20 p.m.

H. FOLLOW-UP:

1. McCammon will send to PAG members the draft of the Report to Congress.
2. McCammon will add one PAG field trip to the FY 2002 budget. PAG members are to

think about what/where they would like to visit next spring or fall.

3. PAG members are encouraged to submit detailed comments on the GEM document to the Trustee Council as soon as possible via email to: restoration@oilspill.state.ak.us.
4. McCammon will arrange a teleconference to discuss herring projects for FY 2002. Hull, Baker and Meacham will participate.

I. NEXT MEETINGS: PAG, tentatively the week of December 10, 2001
Trustee Council, August 6, 2001, 8:30 a.m.

J. ATTACHMENTS: (Handouts, for those not present)

1. Travel Summary
2. State of Alaska Travel Regulations
3. FY 2002 EVOS Budget for Public Information, Science, Administration
4. GEM Overview Figure
5. Schubert Memo on Possible Models for PAG
6. Mundy Memo on Herring Research Options
7. Changes in Executive Director's Recommendation (FY 2002 work plan)

K. CERTIFICATION:

______________________________ ____________

PAG Chairperson **Date**

Archaeology Status Report

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

TO: Trustee Council

FROM: Molly McCammon
Executive Director

RE: Project 99154 / Archaeological Repository, Local Display Facilities and Traveling Exhibits - Prince William Sound and Lower Cook Inlet
Project 02154 / Support Costs

DATE: July 27, 2001

In a resolution dated January 22, 1999, the Trustee Council authorized $2.8 million for a grant to Chugachmiut, Inc., to develop an archaeological repository for Prince William Sound and lower Cook Inlet, local display areas in seven communities in those regions, and traveling exhibits to display in the local facilities. The Trustee Council has allocated $777,000 to an archaeological repository in Seward, $1,823,000 to local display facilities in eight communities (Chenega Bay, Cordova, Nanwalek, Port Graham, Seldovia, Seward, Tatitlek and Valdez), and $200,000 to the development of traveling exhibits. The purpose of this memo is to give you a status report on this project and request associated support costs.

Status Report

Repository: The regional repository will occupy part of the first floor of the Orca Building in Seward, on the northwest corner of Washington St. and Third Ave. Chugachmiut owns the entire building. Earlier this year, Chugachmiut received a grant from the Denali Commission to complete the unfinished space on the first floor. The unfinished space will serve as a dental clinic and offices. A 1,700-sf space on the first floor will be converted into a multi-purpose room that could accommodate meeting and exhibits.

Chugachmiut has contracted with the architectural firm of Livingston Slone to design the first floor of the Orca Building. The design should be completed by late August 2001. Chugachmiut projects that remodeling will be complete by the end of the calendar year.

Local Display Facilities: All eight communities have submitted proposals for local display facilities, which in most cases require funding from multiple sources. Chugachmiut has entered into contracts with Eyak and Port Graham for development of their facilities. Negotiations with the other six communities continue. The following is a brief description of the local display facilities proposed for each community:

- *Chenega Bay*: The Chenega Bay IRA Council plans to build a new 768-sf local display facility on land donated by the Chenega Corporation. The facility will include an exhibit gallery, a USFS kiosk, storage area, and mechanical room.

- *Eyak/Cordova*: The Native Village of Eyak (NVE) will include a local display facility on the first floor of the Mariner Building in Cordova. NVE owns the building. Construction begins this month. This is the first local display facility that I have approved for construction.

- *Port Graham*: The Port Graham Village Council plans to renovate a 625-sf space in the Port Graham Corporation building to serve as a display area. The corporation will donate the space and major maintenance. The Council has entered into a contract for design of the local display facility.

- *Nanwalek*: The Nanwalek IRA Council proposed a 500-sf exhibit gallery in a new community building. Design and construction of this building have been postponed while the IRA Council seeks funding for the entire project. The Council has submitted an application for a $500,000 Indian Community Development Block Grant (ICDBG) and obtained a commitment from the English Bay Corporation to contribute funds to the project.

- *Seldovia*: The Seldovia Village Tribe plans to incorporate a local display facility into a new Maritime Mall. This project will be built on the site of an old cannery. The Tribe has recently received a $2 million EDA grant for this project.

- *Seward*: The Qutekcak Native Tribe plans to locate an 840-sf local display facility in a new tribal building to be built on a vacant lot on Third Avenue in Seward. The site of the new building is 300 ft. north of the repository. The Qutekcak Native Tribe has arranged to use AVTEC student labor to help construct the building.

- *Tatitlek*: The Tatitlek IRA Council plans to renovate the existing Community Center to provide for an 800-sf local display facility. The Community Center formerly housed a small museum, but the museum was disbanded several years ago. The renovation will include upgrades to the heating system, electrical system, insulation and flooring.

- *Valdez*: The Valdez Native Tribe and the Valdez Museum and Historical Archive Association, Inc., submitted a joint proposal for a 4,000-sf expansion of the existing museum. The expansion will include a 500-sf local display area. The total cost of the expansion is $1,030,000. Construction will take place in the summer of 2003.

Traveling Exhibits: The Trustee Council has authorized $200,000 for development of exhibits relevant to the archaeological resources injured as a result of the spill. The grant agreement specifies that Chugachmiut will develop eight exhibits, one for each of the local display facilities. Planning and design of the exhibits will begin soon after the repository has begun operations and will be completed by September 30, 2002.

Support Costs
In the resolution authorizing this project, the Council stated its intent to provide a reasonable amount of funding for project management and general administration to be approved by the Trustee Council at each phase of project implementation. The table below summarizes support costs for this project.

I estimate support costs for FY 02 to be no more than $29,100. These support costs will be allocated as follows: $5,500 for up to one month of project management; $3,800 for up to 0.5 months of oversight by Judy Bittner, the State Historic Preservation Officer; and $19,800 for General Administration.

	Authorizations				Request	Total
	Sept.1999	Feb. 2000	Aug. 2000	Dec. 2000	Aug. 2001	
Grant	89,000	180,000	869,000	742,000	920,000	2,800,000
Support Costs						
Business Plan Review	20,000					20,000
Project Management	7,300	7,300	11,000	5,500	5,500	36,600
Project Oversight (SHPO)	3,800	3,800	7,600	3,800	3,800	22,800
GA - contractual	7,630	10,650	17,380	14,840	18,400	68,900
GA - personnel	1,665	1,665	2,790	1,395	1,395	8,910
Subtotal support costs (computed):	40,395	23,415	38,770	25,535	29,095	157,210
Subtotal support costs (rounded):	40,400	23,500	38,800	25,500	29,100	157,300

Issue
By prior Trustee Council action, support costs will lapse on September 30, 2002. Although most of the work will be completed by that time, two tasks will continue into FY 03. The local display facility in Valdez will be constructed during the summer of 2003. Chugachmiut will plan the traveling exhibits during FY 02, but not build and install them until FY 03. These two tasks and any other work that may be delayed will require that support costs be expended in FY 03.

Executive Directors' Recommendation
1. Approve $29,100 in additional support costs for the Alaska Department of Natural Resources for Project 02154. This recommendation will be included in the Work Plan motion.
2. Extend to September 30, 2003, the lapse date for support costs approved in prior years ($128,200).

Defer and New

00195

DEF[illegible]S: FY 02 WORK PLAN

Proj. No.	Project Title	Lead Agency	Proposer	ED Rec.	FY 02 Recom.
02052	Community Involvement	ADFG	P. Brown- Schwalenberg/CRRC	Fund contin / Defer	$180.0
02159	Seabird Boat Surveys	DOI	D. Irons/USFWS	Defer; lower priority	$194.1
02190	Linkage Map for the Pink Salmon Genome	ADFG	F. Allendorf/Univ. Montana	Fund / Defer	$168.0
02320	SEA: Printing Final Report	ADFG	W. Hauser/ADFG	Defer	$6.2
02538	Methods to Discriminate Herring Stocks	ADFG	T. Otis/ADFG, R. Heintz/NOAA	Fund contin / Defer	$80.4
02543	Oil Remaining in the Intertidal	NOAA	J. Short/NOAA	Fund contin / Defer	$363.1
02552-BAA	Exchange Between PWS and GOA	NOAA	S. Vaughan/PWSSC	Defer	$102.5
02556	Mapping Marine Habitats	ADFG	C. Schoch/Kachemak Bay NERR	Defer	$5[illegible]
02574-BAA	Bivalve Recovery on Treated Beaches	NOAA	D. Lees/Littoral Eco.& Environ. Services	Defer	$94.8
02578	Macrofauna Annotated List	NOAA	N. Foster, H. Feder	Defer; lower priority	$35.0
02584	Airborne Remote Sensing Tools	ADFG	E. Brown/UAF, J. Churnside/NOAA	Defer	$75.0
02600	EVOS Synthesis, 1989-2001	ADNR	R. Spies/EVOS Chief Scientist, et al	Defer	$151.6
02603	Ocean Circulation Model	ADFG	J. Wang/UAF	Defer	$66.4
02621	Kenai River Flats Conservation Easement	ADFG	M. Kuwada/ADFG	Defer	$141.0
02622	Digital ESI Maps: Cook Inlet/Kenai Peninsula	NOAA	J. Whitney/NOAA	Defer; lower priority	$36.6
02624-BAA	Ships of Opportunity: CPR-Based Plankton Survey	NOAA	S. Batten/SAHFOS, D. Welch/DFOC	Defer	$133.4
02630	Planning for GEM	ALL	Restoration Office	Fund / Defer	$200.0
02634	STAMP	DOI	D.Roseneau/USFWS, G.York/BRD, P.Becker/NIST	Defer; lower priority	$5[illegible]
02636-BAA	Ecosystem Recovery: Spill-Impacted Communities	NOAA	K. Adams, B. Perrine, R. Mullins/Cordova	Defer	$50.0
02659-BAA	Manuscripts: SEA & NVP Avian Predation	NOAA	M. Bishop/PWSSC	Defer	$29.7
02668	Interactive Water Quality and Habitat Database	ADEC	J. Cooper/Cook Inlet Keeper	Defer	$16.1
02680	Persistent Organic Contaminants in Alaska Fishes	NOAA	S. Rice, J. Short, A. Moles/NOAA	Defer	$75.6
02681	Placeholder: Nearshore/Intertidal Monitoring		To be determined	Defer	$50.0
					$2,036.5

Note: Total reflects that a portion of projects 02052 ($45.0), 02190 ($43.1), 02538 ($ 52.9), 02543 ($113.1), and 02630 ($63.8) is NOT deferred.

NEW PROJECTS RECOMMENDED FUND OR DEFER: FY 02 WORK PLAN

Proj. No.	Project Title	Lead Agency	Proposer	ED Rec.	FY 02 Recom.
02395	Nearshore/Intertidal Monitoring Workshop	DOI	T. Dean/Coastal Resources Associates, C. Schoch/Kachemak Bay NERR	Fund contingent	$63.6
02556	Mapping Marine Habitats	ADFG	C. Schoch/Kachemak Bay NERR	Defer	$50.0
02561	Community-Based Forage Fish Sampling	DOI	D. Roseneau/USFWS	Fund	$54.3
02574-BAA	Bivalve Recovery on Treated Beaches	NOAA	D. Lees/Littoral Eco.& Environ. Services	Defer	$94.8
02578	Macrofauna Annotated List	NOAA	N. Foster, H. Feder	Defer; lower priority	$35.0
02584	Airborne Remote Sensing Tools	ADFG	E. Brown/UAF, J. Churnside/NOAA	Defer	$7[illegible]
02593	River Otter Synthesis	ADFG	S. Jewett/UAF	Fund	$32.4
02600	EVOS Synthesis, 1989-2001	ADNR	R. Spies/EVOS Chief Scientist, et al	Defer	$151.6
02603	Ocean Circulation Model	ADFG	J. Wang/UAF	Defer	$66.4
02608	Archiving of Nearshore & Deep Benthic Specimens	ADFG	N. Foster/UAF	Fund	$61.6
02612	Marine-Terrestial Linkages in Kenai River Watershed	ADFG	W. Hauser/ADFG	Fund	$44.6
02614	Monitoring Temperature, Salinity, and Fluorescence	ADFG	S. Okkonen/UAF	Fund contingent	$38.2
02621	Kenai River Flats Conservation Easement	ADFG	M. Kuwada/ADFG	Defer	$141.0
02622	Digital ESI Maps: Cook Inlet/Kenai Peninsula	NOAA	J. Whitney/NOAA	Defer; lower priority	$3[illegible]
02624-BAA	Ships of Opportunity: CPR-Based Plankton Survey	NOAA	S. Batten/SAHFOS, D. Welch/DFOC	Defer	$133.4
02634	STAMP	DOI	D.Roseneau/USFWS, G.York/BRD, P.Becker/NIST	Defer; lower priority	$54.9
02636-BAA	Ecosystem Recovery: Spill-Impacted Communities	NOAA	K. Adams, B. Perrine, R. Mullins/Cordova	Defer	$50.0
02649	Reconstructing Sockeye Populations	ADFG	B. Finney/UAF	Fund contingent	$88.1
02656	Nearshore Analysis: Archaeology & Isotopes	DOI	G. Irvine/USGS, J. Schaaf/NPS	Fund	$109.9
02659-BAA	Manuscripts: SEA & NVP Avian Predation	NOAA	M. Bishop/PWSSC	Defer	$29.7

NEW PROJECTS RECOMMENDED FUND OR DEFER: FY 02 WORK PLAN

Proj. No.	Project Title	Lead Agency	Proposer	ED Rec.	FY 02 Recom.
02667	Effectiveness of Citizens' Environmental Monitoring	ADEC	S. Mauger/Cook Inlet Keeper	Fund	$16.7
02668	Interactive Water Quality and Habitat Database	ADEC	J. Cooper/Cook Inlet Keeper	Defer	$16.1
02671-BAA	Ships of Opportunity: Kachemak Bay & Lower Cook Inlet	ADFG	D. Stram, C. Schoch/Kachemak Bay NERR	Fund	$34.8
02674-BAA	Pigeon Guillemot Restoration Techniques	NOAA	J. French/Pegasus Enterprises, G. Divoky/UAF	Fund	$42.6
02680	Persistent Organic Contaminants in Alaska Fishes	NOAA	S. Rice, J. Short, A. Moles/NOAA	Defer	$75.6
02681	Placeholder: Nearshore/Intertidal Monitoring		To be determined	Defer	$50.0
					$1,646.9

NOTE: The sum of new projects recommended FUND and FUND CONTINGENT is $586.8.

ASLC Bench Fees

ALASKA SEALIFE CENTER
BENCH FEES
Executive Director's Recommendation
FY 02 WORK PLAN

Project Number	Project Budget	Bench Fees	GA on Bench Fees	New Project Total	Sum of Bench Fees & GA
02423 Population Change: NVP (Esler)	$329.7	$120.3	$8.4	$458.4	$128.7
02558 Harbor Seal Health (Atkinson)	$128.4	$153.2	$10.7	$292.3	$163.9
02674 Pigeon Guillemot Restoration (French)	$42.6	$16.6	$1.2	$60.4	$17.8
	$500.7	$290.1	$20.3	$811.1	$310.4

Public Comment

PUBLIC COMMENT RECEIVED
FY 02 DRAFT WORK PLAN

TOPIC:	COMMENTER:	COMMENT:	FORM OF COMMENT:
Fall herring surveys	Chris Blackburn, Alaska Groundfish Data Bank & PAG	Support	Letter attached
	Charles Meacham, PAG	Support	Letter attached

In addition, the proposer of the following project testified at a public hearing on behalf of her proposal:

02052	Community involvement	Patty Brown-Schwalenberg, Chugach Regional Resources Commission	7/5/01 PAG meeting

PUBLIC ADVISORY GROUP COMMENTS ON THE FY 02 WORK PLAN:
No motion was made or passed. However, several PAG members agreed that further consideration should be given to fall/winter herring surveys (Project 02457), a ships-of-opportunity program in Prince William Sound (see Projects 02636 and 02671), and expanding the sockeye population reconstruction project to some lakes on the outer Kenai Peninsula coast (Project 02649).

ALASKA GROUNDFISH DATA BANK P.O. 948 KODIAK AK 99615
PH: 907-486-3033 *** FAX 907-486-3461
CHRIS BLACKBURN, PROPRIETOR ** EMAIL 7353974@mcimail.com
INTERNET EMAIL cbburn@ptialaska.net
JULIE BONNEY, EXECUTIVE ASSISTANT ** EMAIL jbonney@eagle.ptialaska.net

MOLLY McCAMMON	6/8/01

MOLLY - I AM IN AWE OF HOW WELL YOU MANAGE TO KEEP US ON TRACK AND PRODUCTIVE -- MAKES THE MEETINGS FUN

AFTER A NIGHT'S SLEEP I FEEL EVEN MORE STRONGLY THAN I DID AT THE MEETING THAT PROPOSAL 02457 FALL/WINTER HERRING SHOULD BE FUNDED AT $86,000

SINCE HERRING ARE VITAL FOR REPRODUCTION OF MANY BIRDS, GROWTH OF FISH AND PROBABLY A NUMBER OF MARINE MAMMALS I THINK MORE ATTENTION SHOULD BE PAID TO HERRING OUTSIDE THE SPRING SEASON AND PROPOSAL 02457 FALL/WINTER HERRING IS A REASONABLE START

CHRIS BLACKBURN

Sandra Schubert

From: Molly McCammon [molly_mccammon@oilspill.state.ak.us]
Sent: Friday, June 08, 2001 2:34 PM
To: Sandra Schubert
Subject: FW: FY02 Draft Work Plan

-----Original Message-----

From: **Charles P. Meacham [mailto:ffcpm1@aurora.alaska.edu]**
Sent: Friday, June 08, 2001 10:50 AM
To: Molly McCammon
Subject: Re: FY02 Draft Work Plan

Molly,

I enjoyed participating in the Restoration Work Force review meeting yesterday. Your staff put considerable effort into making the review process possible for us which is rather remarkable in view of the large number of proposals submitted. Thank you for your efforts!

I remain very interested in the herring component of the work plan. It is pleasing to see some efforts being directed to answering questions about disease and stock identification. However, you may want to ask for reconsideration of the "do not fund" preliminary recommendation for the Fall-Winter Herring Proposal (02457). I re-read this proposal last night and think it has merit.

It also appears that this project represents a cooperative effort with other investigators including Alaska Department of Fish and Game and the Oil Spill Recovery Institute and is an opportunity to leverage funds.

I know that I may have pushed a bit hard to fund herring projects, but this species is critically important to many other fish, birds, and mammals. The dramatic fluctuations in herring abundance and recruitment from year-to-year are measured in orders of magnitude (when abundance is successfully measured, anyway!) with no scientific explanation or good understanding of the relative importance of oil impacts, fishery impacts, or natural environmental conditions to this variability. I would really like to see EVOS fund this project and be a significant contributor to solving the herring mystery.

Apparently herring in Prince William Sound are also at the lowest levels ever measured.

I'm sure that the residents of the area also share my interest.

Again, thank you for the opportunity to participate in the review process.

Best wishes,

Chuck Meacham

02100 Budget

Budget Category:	Authorized FFY 2001	Proposed FFY 2002	PROPOSED FFY 2002 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
			$23.0	$970.5	$307.6	$20.0	$156.3	$22.6
Personnel	$622.2	$650.9						
Travel	$69.2	$97.6						
Contractual	$658.4	$602.0						
Commodities	$15.3	$15.3						
Equipment	$3.4	$3.4	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$1,368.5	$1,369.1		Estimated FFY 2003				
General Administration	$131.5	$130.9						
Project Total	$1,500.0	$1,500.0		TBD				
Full-time Equivalents (FTE)	8.2	8.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This budget reflects further reduction of expenses associated with administration of the restoration program .

This budget:
* contractual costs in FY 02 are lower than FY 01 by $56.4.
* DOI's budget has increased significantly because the building lease is through DOI instead of ADF&G. The increase in the lease cost is because the current lease cannot be renewed and a new lease will cost more than the current one due to increased market rates;
*personnel costs in FY02 are higher than FY01 because of annual salary increases (with no reduction in staff);
*reduces the Chief Scientist's contract by $23.7.

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration
Agency: Multiple

FORM 2A
MULTI-TRUSTEE
AGENCY SUMMARY

PREPARED: 7/27/01

Budget Category:	Authorized FFY 2001	Proposed FFY 2002						
Personnel	$0.0	$0.0						
Travel	$0.0	$0.0						
Contractual	$293.7	$270.0						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$293.7	$270.0		Estimated FFY 2003				
General Administration	$18.4	$17.9						
Project Total	$312.1	$287.9		TBD				
Full-time Equivalents (FTE)	0.0	0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Chief Scientist and Peer Reviewers
Agency: AK Dept. of Natural Resources

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 2002
	Subtotal		0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 2002
				Travel Total	$0.0

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Chief Scientist and Peer Reviewers
Agency: AK Dept. of Natural Resources

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 2002
Contract to provide scientific support to the Trustee Council, including the services of the Chief Scientist and Peer Reviews. This is the last year for the contract currently in place. The contractor is paid monthly based upon services rendered.	270.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$270.0

Commodities Costs:	Proposed
Description	FFY 2002
Commodities Total	$0.0

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Chief Scientist and Peer Reviewers
Agency: AK Dept. of Natural Resources

FORM 3B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 2002
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Chief Scientist and Peer Reviewers
Agency: AK Dept. of Natural Resources

FORM 3B
Equipment
DETAIL

Budget Category:	Authorized FFY 2001	Proposed FFY 2002	PROPOSED FFY 2002 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
				$925.2			$132.5	
Personnel	$529.8	$555.6						
Travel	$38.4	$52.8						
Contractual	$364.7	$332.0						
Commodities	$15.3	$15.3						
Equipment	$3.4	$3.4	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$951.6	$959.0		Estimated FFY 2003				
General Administration	$99.3	$98.7						
Project Total	$1,050.8	$1,057.7		TBD				
Full-time Equivalents (FTE)	7.2	7.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

2002

Project Number: 02100
Project Title: Administration, Public Information and Scientific Management - Restoration Office
Agency: Multiple

SUMMARY

Budget Category:	Authorized FFY 2001	Proposed FFY 2002						
Personnel	$512.4	$538.2						
Travel	$38.4	$52.8						
Contractual	$364.7	$219.5						
Commodities	$15.3	$15.3						
Equipment	$3.4	$3.4	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$934.2	$829.1		Estimated FFY 2003				
General Administration	$96.7	$96.1						
Project Total	$1,030.8	$925.2		TBD				
Full-time Equivalents (FTE)	7.0	7.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

The Administrative Assistant II (P. Banks) position ($50.4) is funded through ADF&G General Administration funds.

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Restoration Office
Agency: AK. Dept. of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 2002
McCammon	Executive Director		12.0	11.2		134.0
Mundy	Science Coordinator		12.0	10.0		119.6
Schubert	Program Coordinator		12.0	8.8		105.0
Hennigh	Special Assistant		12.0	6.2		73.9
Banks	Administrative Assistant II *		12.0	4.2		0.0
Womac	Administrative Assistant II		12.0	4.8		57.6
Hall	Administrative Clerk		12.0	4.0		48.0
Overtime					0.0	0.0
* Note: This position supported with GA funds ($50.4).	Subtotal		84.0	49.1	0.0	
					Personnel Total	$538.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 2002
In-State Travel					
Anchorage to Juneau (administrative travel)	0.4	20	38	0.2	15.6
Anchorage to spill area community (3 staff/1 transcriber for TC mtg)	0.2	4	8	0.2	2.4
Workshop Travel					5.0
Community involvement/public meetings	0.2	6	12	0.2	3.6
Car rental (daily rate of $45.00)			14		0.6
Out-of-State Travel					
Anchorage - Washington D.C.	1.4	6	15	0.2	11.4
National conferences/meetings	1.4	6	10	0.2	10.4
Investment training travel	0.5	4	6	0.2	3.2
Car Rental (daily rate of $45.00)			12		0.5
				Travel Total	$52.8

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Restoration Office
Agency: AK. Dept. of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs: Description	Proposed FFY 2002
2002 Audit Engagement	55.0
Phone, teleconferencing and fax	30.0
Postage (metered mail 6.0, bulk mail 5.0)	11.0
Courier service	3.5
Parking (7 spaces * $50 * 12 mon = $4,200)	4.2
Annual Restoration Status Report	10.0
Newsletter (2 issues: printing at $1,400 each)	2.8
Annual Invitation	5.5
Final Work Plan	1.2
Draft Work Plan	2.5
Equipment Maintenance Agreements (copiers, fax machines, postage meter in Anchorage)	11.8
Local Area Network/Web Server support contract (out source)	32.0
Public Notice (TC meetings 1.5, PAG 1.0, other meetings 0.5)	3.0
ADA Compliance (special access to meetings)	1.0
Transcription Services	5.0
Staff training	3.0
Annual Restoration Workshop	20.0
Other printing and publications	4.0
Meeting space rental (out of building)	1.0
56KB Line /DIS-WAN Access (ATU connect charges/dail-up 0.9, WAN/e-mail 4.2)	8.0
Investment Training/Working Group Costs	5.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$219.5

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Restoration Office
Agency: AK Dept. of Fish and Game

FORM 3B
Contractual & Commodities DETAIL

Commodities Costs:	Proposed
Description	FFY 2002
Office Supplies	11.0
Local Area Network Software and Upgrades	2.3
Data Processing Supplies	2.0
Commodities Total	$15.3

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Restoration Office
Agency: AK. Dept. of Fish and Game

FORM 3B
Contractual &
Commodities
DETAIL

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FFY 2002
Replacement Computers	2	1.2	2.4
Office Equipment			1.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$3.4

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Restoration Office
Agency: AK. Dept. of Fish and Game

FORM 3B
Equipment
DETAIL

Budget Category:	Authorized FFY 2001	Proposed FFY 2002						
Personnel	$17.4	$17.4						
Travel	$0.0	$0.0						
Contractual	$0.0	$112.5						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$17.4	$129.9		Estimated FFY 2003				
General Administration	$2.6	$2.6						
Project Total	$20.0	$132.5						
Full-time Equivalents (FTE)	0.2	0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

No GA will be paid to USGS (sponsor for the building leased space) per agreement with USGS.

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Restoration Office
Agency: Dept. of the Interior

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 2002
Baldauf	Federal Budget Officer		2.0	8.7		17.4
	Subtotal		2.0	8.7		
					Personnel Total	$17.4

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 2002
				Travel Total	$0.0

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Restoration Office
Agency: Dept. of the Interior

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 2002
Building Lease Space (USGS sponsored) - 9 months at $10,696/mo, 3 mo reduced rate plus 8% GSA fee & $.14/sq ft service charge	112.5
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$112.5

Commodities Costs:	Proposed
Description	FFY 2002
Commodities Total	$0.0

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Restoration Office
Agency: Dept. of the Interior

FORM 3B
Contractual &
Commodities
DETAIL

New Equipment Purchases:			
Description	Number of Units	Unit Price	Proposed FFY 2002
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage:		
Description	Number of Units	Inventory Agency

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Restoration Office
Agency: Dept. of the Interior

FORM 3B
Equipment
DETAIL

Budget Category:	Authorized FFY 2001	Proposed FFY 2002	PROPOSED FFY 2002 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
				$27.8			$3.5	
Personnel	$3.0	$3.0						
Travel	$13.8	$27.8						
Contractual	$0.0	$0.0						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$16.8	$30.8		Estimated				
General Administration	$1.0	$0.5		FFY 2003				
Project Total	$17.8	$31.3		TBD				
Full-time Equivalents (FTE)	0.1	0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Public Advisory Group
Agency: Multiple

SUMMARY

Budget Category:	Authorized FFY 2001	Proposed FFY 2002						
Personnel	$0.0	$0.0						
Travel	$13.8	$27.8						
Contractual	$0.0	$0.0						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$13.8	$27.8		Estimated FFY 2002				
General Administration	$0.5	$0.0						
Project Total	$14.3	$27.8		TBD				
Full-time Equivalents (FTE)	0.0	0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Budget based on 4 meetings of the Public Advisory Group (two meetings in person and two by teleconference). PAG phone costs, printing and copying are a shared expense in the Operations component.

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Public Advisory Group
Agency: AK Dept. of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 2002
						0.0
	Subtotal		0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 2002
Member travel from various locations					
Regular meetings (1 one day meeting/1 two day meeting)					10.8
Other meetings/reviews (e.g., Restoration Workshop)					3.0
Note: In person meeting cost is approximately $4,900 per meeting for travel and per diem expenses. For a 2 day meeting, add $1,000 in per diem costs. Teleconference meetings cost approximately $600 per meeting.					
Member field trip					14.0
				Travel Total	$27.8

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Public Advisory Group
Agency: AK Dept. of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 2002
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 2002
Commodities Total	$0.0

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Public Advisory Group
Agency: AK Dept. of Fish and Game

FORM 3B
Contractual & Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 2002
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Public Advisory Group
Agency: AK Dept. of Fish and Game

FORM 3B
Equipment
DETAIL

Budget Category:	Authorized FFY 2001	Proposed FFY 2002						
Personnel	$3.0	$3.0						
Travel	$0.0	$0.0						
Contractual	$0.0	$0.0						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$3.0	$3.0		Estimated FFY 2003				
General Administration	$0.5	$0.5						
Project Total	$3.5	$3.5		TBD				
Full-time Equivalents (FTE)	0.1	0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Public Advisory Group
Agency: Dept. of the Interior

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 2002
Mutter	Regional Environmental Assistant		0.5	6.0		3.0
	Subtotal	[redacted]	0.5	6.0	0.0	[redacted]
					Personnel Total	$3.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 2002
				Travel Total	$0.0

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Public Advisory Group
Agency: Dept. of the Interior

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 2002
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 2002
Commodities Total	$0.0

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Public Advisory Group
Agency: Dept. of the Interior

FORM 3B
Contractual & Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 2002
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Public Advisory Group
Agency: Dept. of the Interior

FORM 3B
Equipment
DETAIL

Budget Category:	Authorized FFY 2001	Proposed FFY 2002	PROPOSED FFY 2002 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
			$23.0	$17.5	$19.8	$20.0	$20.3	$22.6
Personnel	$89.4	$92.3						
Travel	$17.0	$17.0						
Contractual	$0.0	$0.0						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$106.4	$109.3						
General Administration	$13.4	$13.8						
Project Total	$119.8	$123.1						
Full-time Equivalents (FTE)	1.0	1.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FFY 02 budget reflects 2 months funding for each agency liaison.

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support

SUMMARY

Budget Category:	Authorized FFY 2001	Proposed FFY 2002
Personnel	$16.6	$17.8
Travel	$2.5	$2.5
Contractual	$0.0	$0.0
Commodities	$0.0	$0.0
Equipment	$0.0	$0.0
Subtotal	$19.1	$20.3
General Administration	$2.5	$2.7
Project Total	$21.6	$23.0
Full-time Equivalents (FTE)	0.2	0.2
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Dollar amounts are shown in thousands of dollars.

Comments:

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: AK Dept. of Environmental Conservation

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 2002
See	Agency Liaison		2.0	8.9		17.8
	Subtotal	[redacted]	2.0	8.9	0.0	[redacted]
					Personnel Total	$17.8

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 2002
Trustee and Agency Travel					2.5
				Travel Total	$2.5

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: AK Dept. of Environmental Conservation

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 2002
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 2002
Commodities Total	$0.0

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: AK Dept. of Environmental Conservation

FORM 3B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 2002
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: AK Dept. of Environmental Conservation

FORM 3B
Equipment
DETAIL

Budget Category:	Authorized FFY 2001	Proposed FFY 2002
Personnel	$13.6	$12.2
Travel	$3.5	$3.5
Contractual	$0.0	$0.0
Commodities	$0.0	$0.0
Equipment	$0.0	$0.0
Subtotal	$17.1	$15.7
General Administration	$2.0	$1.8
Project Total	$19.1	$17.5
Full-time Equivalents (FTE)	0.2	0.2
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Dollar amounts are shown in thousands of dollars.

Comments:

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: AK Dept. of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 2002
Hauser	Agency Liaison		2.0	6.1		12.2
	Subtotal		2.0	6.1	0.0	
					Personnel Total	$12.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 2002
Trustee and Agency Travel					3.5
				Travel Total	$3.5

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: AK Dept. of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 2002
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 2002
Commodities Total	$0.0

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: AK Dept. of Fish and Game

FORM 3B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 2002
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: AK Dept. of Fish and Game

FORM 3B
Equipment
DETAIL

Budget Category:	Authorized FFY 2001	Proposed FFY 2002
Personnel	$14.8	$15.0
Travel	$2.5	$2.5
Contractual	$0.0	$0.0
Commodities	$0.0	$0.0
Equipment	$0.0	$0.0
Subtotal	$17.3	$17.5
General Administration	$2.2	$2.3
Project Total	$19.5	$19.8
Full-time Equivalents (FTE)	0.2	0.2
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Dollar amounts are shown in thousands of dollars.

Comments:

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: AK Dept. of Natural Resources

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 2002
Fries	Agency Liaison		2.0	7.5		15.0
	Subtotal		2.0	7.5	0.0	
					Personnel Total	$15.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 2002
Trustee (Dept of Law) and Agency Travel					2.5
				Travel Total	$2.5

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: AK Dept. of Natural Resources

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 2002
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 2002
Commodities Total	$0.0

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: AK Dept. of Natural Resources

FORM 3B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 2002
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: AK Dept. of Natural Resources

FORM 3B
Equipment
DETAIL

Budget Category:	Authorized FFY 2001	Proposed FFY 2002						
Personnel	$14.8	$15.2						
Travel	$2.5	$2.5						
Contractual	$0.0	$0.0						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$17.3	$17.7						
General Administration	$2.2	$2.3						
Project Total	$19.5	$20.0						
Full-time Equivalents (FTE)	0.2	0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: Dept. of Agriculture, Forest Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 2002
Holbrook	Agency Liaison		2.0	7.6		15.2
	Subtotal		2.0	7.6	0.0	
					Personnel Total	$15.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 2002
Trustee and Agency Travel					2.5
				Travel Total	$2.5

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison
Agency: Dept. of Agriculture, Forest Service

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 2002
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 2002
Commodities Total	$0.0

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: Dept. of Agriculture, Forest Service

FORM 3B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 2002
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: Dept. of Agriculture, Forest Service

FORM 3B
Equipment
DETAIL

Budget Category:	Authorized FFY 2001	Proposed FFY 2002						
Personnel	$12.6	$15.5						
Travel	$2.5	$2.5						
Contractual	$0.0	$0.0						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$15.1	$18.0						
General Administration	$1.9	$2.3						
Project Total	$17.0	$20.3						
Full-time Equivalents (FTE)	0.2	0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: Dept. of the Interior

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 2002
FWS - DeGange	Liaison		1.0	8.5		8.5
NPS - Rice	Liaison		1.0	7.0		7.0
	Subtotal		2.0	15.5	0.0	
					Personnel Total	$15.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 2002
Trustee and Agency Travel					2.5
				Travel Total	$2.5

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: Dept. of the Interior

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 2002
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 2002
Commodities Total	$0.0

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: Dept. of the Interior

FORM 3B
Contractual &
Commodities
DETAIL

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FFY 2002
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: Dept. of the Interior

FORM 3B
Equipment
DETAIL

Budget Category:	Authorized FFY 2001	Proposed FFY 2002						
Personnel	$17.0	$16.6						
Travel	$3.5	$3.5						
Contractual	$0.0	$0.0						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$20.5	$20.1						
General Administration	$2.6	$2.5						
Project Total	$23.1	$22.6						
Full-time Equivalents (FTE)	0.2	0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: National Oceanic & Atmospheric Administration

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 2002
Moles	Agency Liaison		2.0	8.3		16.6
	Subtotal	[redacted]	2.0	8.3	0.0	[redacted]
					Personnel Total	$16.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 2002
Trustee and Agency Travel					3.5
				Travel Total	$3.5

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 2002
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 2002
Commodities Total	$0.0

2002	Project Number: 02100 Project Title: Public Information, Science Management and Administration - Liaison Support Agency: National Oceanic & Atmospheric Administration	FORM 3B Contractual & Commodities DETAIL

New Equipment Purchases:	Number of Units	Unit Price	Proposed FFY 2002
Description			
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number of Units	Inventory Agency
Description		

2002

Project Number: 02100
Project Title: Public Information, Science Management and Administration - Liaison Support
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Equipment
DETAIL

Miscellaneous
Articles and Letter

RECEIVED
JUN 19 2001
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

The Coastal Coalition
P.O. Box 231824
Anchorage, AK 99523

Ms. Molly McCammon,, Executive Director
Exxon Valdez Oil Spill Trustee Council
645 G. Street, Suite 401
Anchorage, AK 99501-3451

via fax: 276-7178
and mail

Re: EVOS Reopener claims

Dear Molly,

I wanted to briefly inquire as to the EVOS Trustee Council's and/or the state and federal government's plans regarding the "Reopener for Unkown Injury" claims as specified in Section 17 of the 1991 consent decree.

I would greatly appreciate hearing from you as soon as possible regarding whether or not the governments intend to pursue collection of the additional $100 million provided for in the consent decree, the protocol for doing so, and the possible uses of the money the council may be considering. I would also appreciate receiving any other information from you regarding the Council's deliberations about this issue.

As I would love to hear your thoughts on the reopener issue, perhaps it would be good for us to meet at some point to go over all of this. Let me know what might work for you on that front.

Again, you folks are to be commended for the wonderful habitat protections you were able to accomplish with the payments so far from Exxon. Congratulations.

I look forward to hearing from you.

Sincerely,

Rick

Rick Steiner,
The Coastal Coalition
Ph: 907-333-3381

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

June 20, 2001

Rick Steiner
The Coastal Coalition
PO Box 231824
Anchorage, AK 99523

Dear Rick:

Thanks for your recent letter regarding the EVOS reopener claims. As you can see from the attached excerpt from the settlement agreement, the decision on whether or not to pursue the reopener lies with the U.S. and State of Alaska governments, not the EVOS Trustee Council. Thus, the persons who will be making this decision are U.S. Attorney General John Ashcroft and Alaska Attorney General Bruce Botelho. To obtain information about the governments' position, I suggest you speak with Bill Brighton of the U.S. Department of Justice and Craig Tillery of the Alaska Department of Law.

It is my understanding that the opportunity to pursue these claims – September 1, 2002 through September 1, 2006 – is limited by the requirements included in this language to one demand. You can be assured that my office and the Trustee Council will be sharing any and all information with the two governments that might be relevant to developing such a claim. Please let me know if I can provide any additional information to you.

Sincerely,

Molly McCammon

Molly McCammon
Executive Director

attorneys fees to any Party. Exxon, Exxon Pipeline, and the State shall enter into and execute all Stipulations of Dismissal, with prejudice, necessary to implement this subparagraph.

(b) Not later than 15 days after Final Approval, each of the claims asserted by the United States and the State against Exxon or Exxon Pipeline in the Federal Court Complaints, except for the claim described in Paragraph 13(d) of this Agreement, each of the counterclaims asserted by Exxon and Exxon Pipeline against the United States or the State in their responses to the Federal Court Complaints, shall be dismissed with prejudice and without an award of costs or attorneys fees to any Party. Exxon, Exxon Pipeline, the United States, and the State shall enter into and execute all Stipulations of Dismissal, with prejudice, necessary to implement this subparagraph.

(c) Each of the claims asserted by Exxon against the Governments or their officials in Exxon Shipping Company, et al. v. Lujan, et al., Civil Action No. A91-219 CIV (D. Alaska) ("Lujan") shall be dismissed with prejudice, and without an award of attorneys fees or costs to any Party, not later than 5 days after United States District Court approval of any agreement(s) between the Governments and the non-Government defendants in Lujan under which all of the non-Government defendants disclaim any right to recover Natural Resource Damages.

Reopener For Unknown Injury

17. Notwithstanding any other provision of this Agreement, between September 1, 2002, and September 1, 2006, Exxon shall pay

The Coastal Coalition

Box 231824 Anchorage, AK 99523

June 23, 2001

Molly McCammon, Executive Director
Exxon Valdez Oil Spill Trustee Council
645 G. Street, Suite 401,
Anchorage, AK 95501

Dear Molly,

Thanks very much for your 6/20 response to my 6/15 inquiry re: the EVOS reopener.

As you have suggested, I have spoken with Craig Tillery with ADOL and Bill Brighton with the US DOL on this issue. I now fully understand that the ADOL and USDOJ will be the responsible agencies on this, as they were back in 1990/1991 on the original settlement.

You were kind to offer additional information if I so desire. In that regard, I would like to request from the Trustee Council a detailed accounting and explanation of all natural resource damages that, ***in the estimation of the Trustee Council***, meet the standard for which the reopener is to be triggered.

That accounting would include any and all damages, as identified by the Trustee Council's substantial research effort, that ***"could not reasonably have been known nor could...have been anticipated by any Trustee from any information in the possession of or reasonably available to any Trustee on the Effective Date (October 8, 1991)."*** This detailed assessment should include all of the relevant scientific information that has been gathered by your research program that supports claims for 'reopener' damages, as specified in Section 17 of the consent decree.

Molly, I sincerely hope that the Council and its many lawyers do not simply resort to playing word games on this important request - this is one of the things that I have been frustrated with on past requests of the Trustee Council.

I would appreciate receiving this detailed compilation of 'not reasonably known nor anticipated damages' as soon as possible so that we can assess the public's options with respect to these damages.

Sincerely,

Rick Steiner

Rick Steiner
The Coastal Coalition
907-333-3381

Paula Banks

From: Molly McCammon [molly_mccammon@oilspill.state.ak.us]
Sent: Friday, May 04, 2001 1:09 PM
To: Gerald Trigg
Cc: Paula Banks; Cherri Womac; Phil Mundy
Subject: RE: Scholarship Program

Importance: High

Mr. Trigg - We also make sure all comments go to the Trustee Council. Yours will be included in the Council's binder for their next meeting, scheduled for August.

Thanks again for taking the time to write us.

Molly McCammon

-----Original Message-----

From: Cherri Womac [mailto:cherri_womac@oilspill.state.ak.us]
Sent: Friday, May 04, 2001 10:05 AM
To: Gerald Trigg
Cc: Molly McCammon; Phil Mundy
Subject: RE: Scholarship Program

Mr.Trigg:

Thank you for your comments on the 2001 Status Report. I forwarded your comments to the Executive Director and Science Coordinator.

Sincerely,
Cherri Womac
Administrative Assistant
Exxon Valdez Oil Spill Trustee Council
Restoration Office
645 G St Ste 401
Anchorage, AK 99501-3451

-----Original Message-----

From: Gerald Trigg [mailto:triggerald@hotmail.com]
Sent: Friday, May 04, 2001 9:54 AM
To: restoration@oilspill.state.ak.us
Subject: Scholarship Program

I read your 2001 Status Report. It is good to see the activity taking place to restore and heal the spill area. I would like to make the following comment regarding future work that will take place in the spill area. It would be good to see Alaskan residents stepping in to assume the jobs on all levels of the recovery, i.e., people could continue in the study of the areas forestry, birds, fish, otters, support people, just to name a few. To ensure that happening, I would like to suggest the Exon Valdez Oil Spill Trustee Council consider funding scholarship for Alaska residents who would eventually step in and do the work throughout the spill area. Thank you for listening. Gerald Trigg.

Steller opportunity

Research funds bail out Seward's struggling Alaska SeaLife Center

By **TOM KIZZIA**
Anchorage Daily News

SEWARD— The Alaska SeaLife Center was born with the mission of saving the endangered Steller sea lion and other marine mammals of the North Pacific. As it turns out, the Steller sea lion is saving the Alaska SeaLife Center.

Ushered into being by then-Gov. Walter J. Hickel in the cash-and-angst era of the early '90s after the Exxon Valdez oil spill, the Seward aquarium opened three years ago this month. It was soon apparent that few tough questions had been asked about the business plan for a facility that nearly everybody seemed to want.

A steady stream of visitors was supposed to make the $56 million showplace a break-even operation. But tourists didn't show up like they were supposed to. For several years, the sealife center hovered on the brink of financial ruin.

Now those perilous times are receding into the past. A flood of federal research money aimed at North Pacific sea lions has solved the center's budget problems — and helped settle a long-standing question about whether the facility was primarily a science center or a tourist attraction.

Still, tough questions about the original sales pitch remain unanswered.

Did the failure of the visitor-funded concept lie in its execution? Did the fault rest with overeager funding agencies, or the overheated imaginations of Seward boosters and their consultants? Or, as a small handful of critics charged at the time, were the faulty visitor projections cooked up to sell an economic development project to government funders, who would then be called on to bail out another Alaska project?

The Alaska SeaLife Center's failure to live up to its promoters' great expectations is a story all too common when big-vision, big-money institutions get built in Alaska. Indeed, the main difference between the center and certain publicly funded fish processors, grain terminals and coal-fired power plants may be the happy ending that is now being written on the shores of Resurrection Bay.

CASH FLOW CRIS

The sealife center opened in May 1998. Its dual mission: do first-class research on the North Pacific, where marine mammals were in trouble, and also draw visitors eager to see and learn about the captive animals under study. Visitors would pay three-fourths of the operating costs.

By October, the center's directors called an emergency retreat on an island in Resurrection Bay to deal with a serious cash-flow crisis. Through loans and delayed payments to vendors and the city of Seward, they kept the doors open in the months that followed, but just barely.

What had gone wrong? Plenty, according to interviews with scientists, government agencies and current and former sealife center officials.

Construction was expensive and beset by problems. Lawsuits led to countersuits. Management turnover was high — four executive directors in the center's first two and a half years. Internal financial controls were so chaotic they had to be scrapped last fall and outsourced.

And visitor goals in the business plan turned out to be a mirage. In the first year, 262,000 visitors had been expected to buy tickets. But only 193,0000 showed up. Then, instead of growing as predicted, the numbers declined sharply.

Meanwhile, some of the researchers who had been expected to flock to the cold-water labs grumbled about the cost of traveling to isolated Seward. Those who did show had their rents jacked up in a scramble for new income. Complaints arose that in the built-in conflict of cultures at the Seward center, the scientists were losing out to the Sea World promoters.

"It came down to questions like, 'Do we give the animals names or not?' " said Christine DeCourtney, the center's external affairs director. "The compromise was that we give them names, but you won't find a 'Woody the sea lion' doll at the Discovery Shop."

Foundations and corporations that had been expected to pay off the construction debt grew skittish, the aquarium tanks sprung leaks and word-of-mouth further depressed visitation. By last summer, the number of visitors had fallen to only a little more than half of what was originally foreseen. Several wealthy friends of the facility, including Hickel, co-signed a bank loan to keep the doors open after the second year.

And then the sea lions saved the day.

FEDERAL BAILOUT

Steller sea lions once thrived in the North Pacific, but their numbers have plummeted mysteriously in recent decades. They continued to decline as the Seward facility was born.

This was bad news not only for the sea lions but for Alaska's $1-billion-a-year groundfish fleet, which faced increasing restriction to protect the endangered marine mammals. It did not, however, turn out to be altogether bad news for the Alaska SeaLife Center.

Citing the need for more sea lion research to stave off fishing closures, Sen. Ted Stevens, R-Alaska, has pumped $32 million in federal funds into the Seward aquarium over the past two years. Much of that money has been used to pay off the center's operating and construction debts, as well as the privately backed loan.

Stevens' efforts were attacked last July on the Senate floor by fellow Republicans, who called the Seward funds "unnecessary, unwanted, unauthorized and unmitigated pork." But Stevens passionately defended the $5 million emergency payment at issue, saying the Seward research facility was weeks away from being forced to close its doors.

"I'm proud of that sealife center," said Stevens, the powerful appropriations chairman, on the floor of the Senate.

This winter, as pressure on the fishing industry mounted, Stevens held up the entire federal budget to wrest more funding for sea lion research. That included $6 million in research grants earmarked specifically for Seward — essentially turning the nonprofit aquarium into a research arm of the federal government.

Together with a new Stevens-sponsored role in distributing additional millions of dollars for future research, the science grants have turned Seward's struggling waterfront attraction into a major player in the booming field of North Pacific research.

Flirting with solvency at last, the center is planning to upgrade exhibits and turn around the steady visitor decline. "I think this summer, and especially next summer, the numbers are going to start going back up again," said sealife center executive director Tylan Schrock, who now expects science to cover almost two-thirds of the operating budget.

Stevens' efforts have raised the public stake in the Seward aquarium to more than $71 million, nearly twice what its promoters originally requested.

"I wasn't happy about being asked to bail it out," Stevens said in a recent interview. "But I was happy that it was there when we needed it to go into this new phase of basic research."

That seems to be the attitude of other sealife center backers today. They are looking ahead, not back. No one is ready to apologize for getting the waterfront project off the ground with a phantom business plan.

"You have to wonder whether they didn't pick the visitation numbers that they needed after looking at the budget," conceded Scott Janke, Seward's city manager and a board member since 1998. "But to me, it's not worth second-guessing at this point. It happened the way it happened. There was never any way the place was going to fail. How could this state let that thing fail?"

THE "OWNER-STATE" CATHEDRAL

Some kind of waterfront aquarium had long been the dream of Seward civic boosters. They had hoped to leverage a small University of Alaska marine science facility and their spectacular setting into a "world-class" facility that would put Seward on the map.

Within weeks of the 1989 oil spill, city officials had a sketched-out plan for top federal and Exxon officials, saying a long-term marine research institution should be Seward's share of any damages compensation.

They found an enthusiastic partner in Hickel, who presided as governor over the division of Exxon's $1 billion criminal and civil settlements. Today, Hickel's words about caring for the North Pacific are etched above the entrance to the sealife center's exhibit hall. Hickel's vision of "stewardship" called for mankind to take an active role in managing resources. Building a great research and education center on Seward's waterfront was a perfect use of restoration money, in the governor's view. Public education was important, but tourism was secondary.

"The great cathedrals of Europe were not built for tourists, but tourists go there," Hickel said in support of the Seward idea.

In 1993, the Legislature approved $12.5 million out of the state's $50 million criminal settlement to design the sealife center. But legislators added a cautionary note. No money could be spent until the Alaska Industrial Development and Export Authority declared the sealife center could be self-supporting. An owner-state cathedral was fine, but legislators didn't want to spend state money to run it.

A marketing plan drawn up by the Seward Association for the Advancement of Marine Science, the nonprofit group promoting the idea, predicted that operating costs, animal rehabilitation and research subsidies could be comfortably covered by expected visitor fees. AIDEA consultants agreed, at least regarding the rough concept. Testing a wide range of visitor numbers, only the most pessimistic showed an operating loss in their analysis. As it would turn out, that pessimistic forecast almost precisely hit the first two years' visitation.

"It really didn't pass the red-face test," said Rick Steiner, a biologist with the University of Alaska Marine Advisory Program and a critic of using spill settlement funds to build such facilities. "They tried to persuade people that it would ultimately be self-supporting, and we found it difficult to believe."

The early emphasis on attracting paying customers made the project a target for environmental groups, who derided it as an economic development project using up money better spent on protecting habitat. One post-spill advocacy group, the Coastal Coalition, called it "a tourist facility masquerading as a research facility." Why build an artificial replica of the Gulf of Alaska, they asked, when the real Gulf was just offshore and still needed protection?

The trustee council overseeing the $900 million civil settlement of the oil spill was skeptical of the Disneyland glitter they detected in the proposal. At the trustees' request, the plan was recast to emphasize research and animal rehabilitation.

Even so, Clinton appointees on the council preferred to spend the money on studying animals and protecting habitat rather than pouring concrete. The logjam broke after Hickel drew aside assistant secretary of the interior George Frampton at a meeting in Alaska. Hickel said he finally persuaded Frampton of the need for Alaska-based research for the North Pacific. Offering a deal helped persuade him, Hickel said: The governor agreed to have state trustees support purchase of Native corporation lands if the feds would back Seward. In February 1994 the trustee council approved $25.9 million for construction.

The $38 million from oil spill funds now in hand was to be all the public money in the facility. The trustee council said money for the remaining visitor attractions would have to be found elsewhere. Seward boosters managed to raise $6 million privately, but it wasn't enough. In 1996, the city of Seward sold $17.5 million in revenue bonds, to be paid off from sealife center income and future donations. The bonds were written to protect the city and state if the project failed. Once again, high visitor forecasts played a role, helping convince investors they'd get their money back.

With 262,000 visitors expected to course through the town of 3,000, most last-minute speculation centered on whether local businesses were ready to handle the crush.

Erected on city-donated land along the waterfront, where it looms over a rundown end of downtown Seward, the sealife center has yet to trigger a building boom. The first-year presentations struck some visitors as half-hearted. Not all exhibits were ready. On opening day, workers finally managed to fill the jellyfish tank with water, only to have it crack under pressure.

Sealife center officials offer several explanations for the disappointing visitor turnout (193,000 the first year, down to 143,000 last year): a lack of focused marketing, a leveling off of Alaska tourism, cruise schedules that whisked passengers straight to Anchorage.

Dale Fox, who drew up several forecasts between 1993 and 1996 as an Anchorage consultant for SAAMS, said his numbers were based on the premise that Seward would come up with an "eye-popping, must-see" project. He said the need to scale back some of the glossy original proposals for financial reasons probably affected visitor numbers.

Fox also said he was pressured, by the project manager and board members, to increase his projections. He said he increased his estimates for cruise ship travelers, based on promises of aggressive marketing efforts that never came to pass.

"They told me, 'You're being too pessimistic. We can do better than that,'" Fox said. Such optimism did not seem out of place at the time, he added. "If it weren't for optimists, no project would get built," he said.

Leif Selkregg, who managed development and construction of the project, said the center never had the marketing budget necessary for such a facility. But he said the long-range importance of research funding was clear all along to professionals involved in the project — even though promoters continued to tout big tourist revenues.

"The early executive directors were tourism-oriented folks," Selkregg said. "It took awhile to find the right people."

With an air of underachievement hovering over the new aquarium, private contributions dried up. And state officials have been more concerned with permits for holding live animals than with providing help to the struggling young facility, said Willard Dunham, a Seward businessman who had helped organize the project.

"The state has been a total disappointment," said Dunham, who is happy with the finished product despite the lack of support. "We had been led to believe corporations would get involved, but the only corporate group that has helped reliably, with money and political pressure, is the trawling industry. Their business is as much at stake as anyone's."

The research wing of the facility didn't start off gangbusters, either. Much of the research was funded by the oil spill trustee council, whose work was already beginning to wind down. The trustee council helped by agreeing to pay higher "bench fees" charged to scientists.

"Research has to be a break-even game," said Shannon Atkinson, the sealife center's science director. "If you count on something else to subsidize research and that doesn't come through, you flounder. Unfortunately, we had some of that."

Researchers who came to Seward to work with the captive animals, particularly the three Steller sea lions, generally had good things to say about the facilities. But tensions grew as panicked managers tried to make the facility more tourist friendly.

"Some people tried to steer it more in a Sea World direction. We didn't need another Sea World," said Markus Horning, a sea lion biologist from Texas A&M Galveston who enjoyed mixing with the Seward public on the scientists' terms.

Don Calkins, a former Department of Fish and Game researcher who headed the Seward sea lion program, said he quit over "fundamental disagreements" on how to spend federal money. He declined to offer details. But managers changed and Calkins is now back at work in Seward, feeding the captive animals different diets to see how a changing Pacific ecosystem might be affecting their survival.

"They finally got the right managers there, who realize this isn't a zoo," said Hickel, who remains a major supporter.

Schrock, who was Seward's assistant city manager when he was hired to run the sealife center last October, said things started turning around once construction lawsuits were settled last fall. Insurance companies paid Strand Hunt Construction $6.2 million for costs incurred by change orders, while the sealife center got $10 million from the settlement to repair cracked concrete, leaking exhibits, peeling paint, defective stainless steel counters and boilers that didn't work.

The city of Seward had been sending official delegations to Washington, D.C., for several years to plead with Stevens for money. Finally, the federal funds started to arrive: $1 million each year for basic sea lion research, $5.1 million in a supplemental 1999 budget, an extra $5 million for 2000, and $6 million for research in the 2001 budget. This year, there's an extra $600,000 for research on another "threatened" species, eider ducks.

Stevens also provided a crucial $14 million to bail out the center's revenue bond debt, whose $150,000 monthly payments were dragging the facility under. Bondholders agreed to forgive the interest owed and walk away from the struggling facility with just their original investment.

"The bond has always been an albatross around the neck of this facility," said Schrock.

Critical as the bond payoff was, it is the direct appropriation of research money that has transformed what the Alaska SeaLife Center is and what its future holds.

NEW CLOUT

The original plan had been to create a well-stocked laboratory available for rent by scientists who got their funding elsewhere, said University of Alaska biologist Michael Castellini, the center's first science director. But with direct appropriations from Congress, he said, the Seward nonprofit has become a virtual funding agency itself, putting scientists on its own payroll to do research.

"With the increased federal allocation to research, they are doing quite well," Castellini said.

Seward's success may be causing mild discomfort in some scientific circles. Rivals aren't so much concerned about funding for sea lion research — there's plenty of that — but competition for qualified researchers. Nine different sea lion scientists are listed on Seward's current research list.

"The key to good research is having good researchers," said Andrew Trites of the University of British Columbia. "There seems to be a shortage of good scientists."

The sealife center's future is even more assured now that Stevens has helped place the facility's head as one of five executive committee members overseeing a huge reservoir of future research money. The North Pacific Research Board is funded from a $900 million pot of money set aside from oil leasing on waters off the Arctic National Wildlife Refuge (the state lost a Supreme Court bid to claim that money in the so-called Dinkum Sands decision of 1997). The board will be dispensing $10 million to $14 million a year for research drawn from interest on the fund.

This summer, visitors to Seward should be able to do more than watch Woody, Kiska and Sugar frolic in their tanks. They may be able to watch researchers implanting instruments in juvenile sea lions captured off the Chiswell Islands. The sea lions will be returned to the wild, under one projected study, where their movements and feeding habits can be monitored more closely than ever before.

The sealife center also has remote-controlled cameras set up on the Chiswell rookeries, with visitors able to watch the marine mammals in the wild. The first new pup of the season was seen on camera just last week.

Scientists at the sealife center hope such research will provide clues that eventually lead to a revival of sea lion populations. After all the sea lions have done for the sealife center, it may be the least they can do.

■ Reporter Tom Kizzia can be reached at tkizzia@adn.com.

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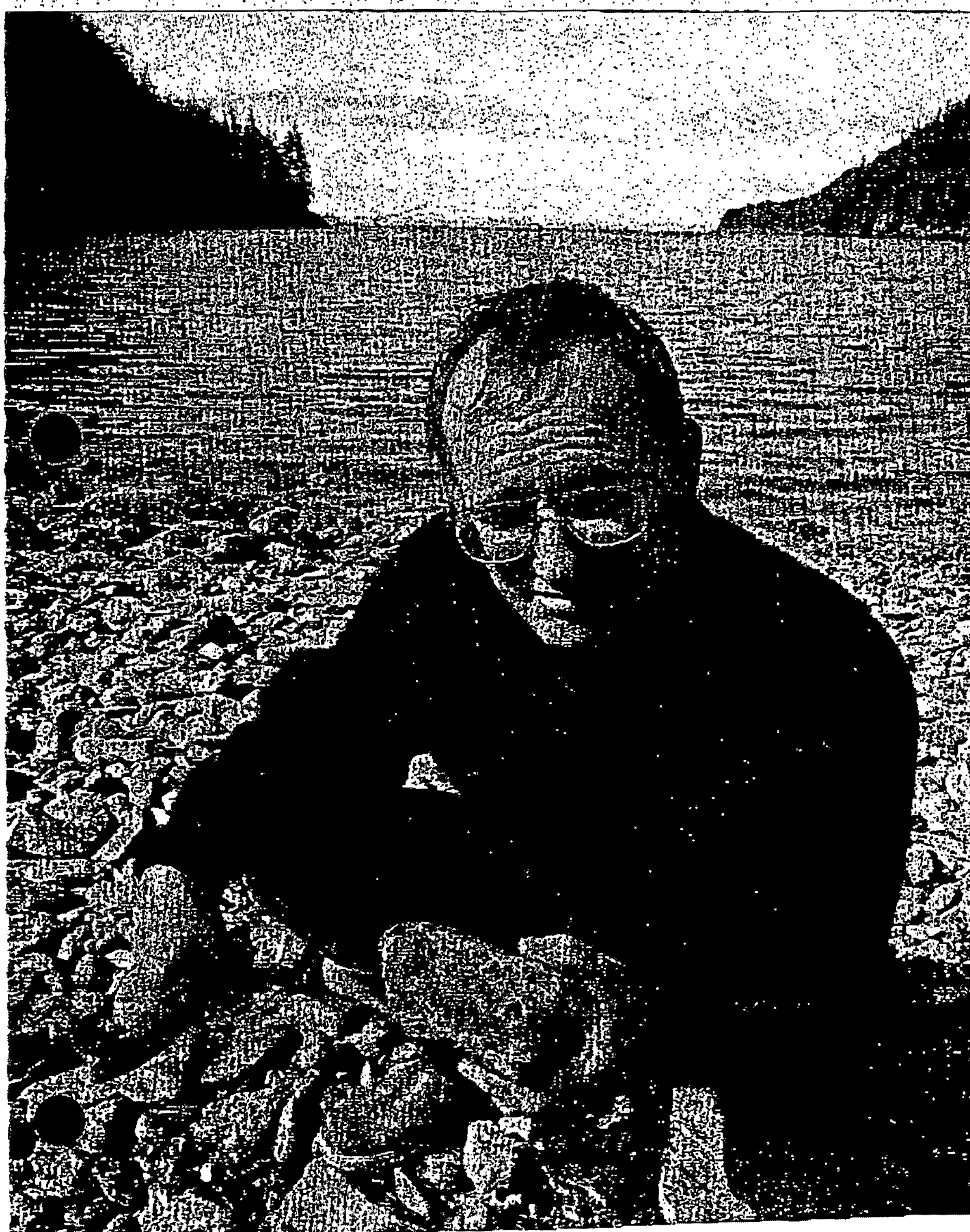
The Voice of Alaska's Capital City Since 1912



Search o for caus of fire in S. Nakne

■ *Blaze destroyed 3 Bristol Bay fishing bo*

THE ASSOCIATED PRESS

ANCHORAGE – State fire n shals began sifting through blackened ruins of a historic c mercial fishing complex in Sc Naknek on Sunday, seeking cause of an explosive fire that c sumed 35 fishing boats and buildings a day earlier.

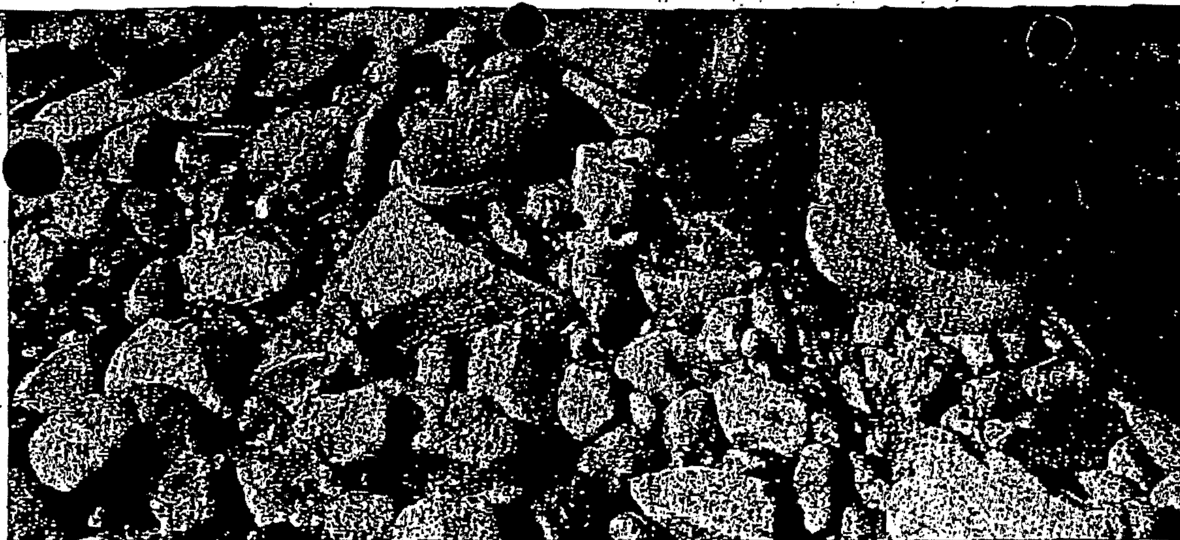
"It's just utter devastation c there," said Ken Blackmon, chie emergency services for the Bri Bay Borough. "There are pudc there of aluminum, and you thinking, 'That's somebody's fi ing boat.'"

South Naknek is a village about 120 across the Naknek Ri from Naknek. The fire came just fishermen were getting ready put their boats in the water for annual run of salmon into Bri Bay. The sockeye season beg last week at Naknek.

Only one fisherman storing boat at the camp lives in Alas The rest are from Oregon, Wa ington and California.

With flames soaring and fi tanks exploding, the fire sw through the complex, owned by I ter Pan Seafoods. At least $3 n lion in vessels were destroyed, b no people were injured.

The fire burned more th possibly p king into t according



MICHAEL DINEEN / THE ASSOCIATED PRESS

Spill residue: Jeff Short, a research chemist with the National Marine Fisheries Service, displays an oil-coated rock in mid-May on the shore of Knight Island in Prince William Sound. The fisheries service is surveying the sound's shoreline to determine the effects of the 1989 Exxon Valdez oil spill.

The big spill revisited

Crews are searching for the Exxon Valdez' long-term effects

By MAUREEN CLARK
THE ASSOCIATED PRESS

KNIGHT ISLAND – Mike Angaiak crouches on his knees on the rocky beach at Snug Harbor, scraping the bottom of a sandy pit with a trowel.

Finding nothing, he fills the pit with sand and rocks and moves on to a spot about six feet away. Angaiak tosses aside rocks and boulders and starts to dig another hole. But this time, the sand beneath the rocks is brown and oily.

"Ugh," he says as he lifts an oiled rock from the freshly dug hole and sniffs it. "You can smell it."

Angaiak, from the Prince William Sound village of

Please see Spill, Page 8

MICHAEL DINEEN / THE ASSOCIATED PRESS

Shoreline survey: A National Marine Fisheries Service survey crew member saves mussels in mid-May for later testing on Knight Island in Prince William Sound.

The rest are from Orego
ington and California.

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tanks exploding, the fi
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ter Pan Seafoods. At leas
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no people were injured.

The fire burned mo
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venting it from leaking
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the U.S. Coast Guard.
burned five boats moore
dock and five fuel tanks, I
spection Saturday aftern
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Guard said.

One fishing boat still h
300 gallons of fuel on b
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The fire mobilized th
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Peter Pan superinten
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Blackmon said.

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watchman had seen th
boiling into the sky and n
thought his own facility h
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Blackmon then bega
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The main fire was co
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...wing down not getting cheaper

...au's grocery prices about ...ent higher than Anchorage's

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...erstand why lemons cost more in Juneau ... look at the

food for a week in March in Juneau was $110.71 for a family of four, including two children 6 to 11 years old.

The same food would cost $84.93 in Portland, Ore.; $102.25 in Anchorage; $173.73 in Bethel; $131.75 in Craig and Klawock; $183.71 in Dillingham; and $98.52 in Fairbanks.

The cost of food for a family of two adults age 20- ... in Juneau and $60.41 in Anchor-

INSIDE:

Alaska
Bridge
Business
Classifieds
Comics
Crossword

[redacted] Juneau Wholesale, which delivers fresh dairy products, fruit, produ ozen foods (including ice cre milk, cheese, eggs, bacon, sausage, French fries and seafood.

Rod Darnell bought the business last September from Douglas Trucking. His main customers are larger restaurants such as the Fiddlehead and the Baranof.

Juneau Wholesale's customers include general stores in villages such as Tenakee, Pelican, Elfin Cove and Gustavus. Groceries and dry goods arrive by state ferries or airplanes, Darnell said.

In addition to the bill for refrigerated containers from Seattle and the big walk-in coolers he has to maintain here, Darnell pins the greater cost of Juneau's food on gasoline.

"Fuel costs 30 cents more a gallon here than in Anchorage. So it costs me a lot more to deliver my produce," he said.

Brian Jenson, general manager for Sysco Food Service Southeast Alaska, has a different take: "Freight cost has not gone up as much as I thought it would with the cost of fuel."

sco wholesales food to gro stores from Dutch Harbor to Prince of Wales Island, and does deli business with Super Bear market and Carrs. Jenson sees the cost of groceries "steadily rising," and links at least two items – chicken and butter – to specific causes.

"The cost of chicken has really gone up since the big beef (foot and mouth) scare in Europe raised the demand for poultry. I think it's scaring a lot of people in the U.S., which it didn't need to," he said.

"The butter market has been going crazy, perhaps because it's commodity-driven. I think Wall Street has a lot to do with the cost of beef and dairy products because they're commodities," Jenson said.

"We are going to be paying for the European beef problem for a couple of years," said Ben Williams, manager of Alaska and Proud market. "Summertime, everybody wants barbecue, wants steak, but we're paying a lot more for these products."

Although fresh beef, poultry and pork are up, that's a national blem, not a Juneau problem, lliams said.

"Percentage-wise, we haven't changed any percentages (of markup) in several years at this market. In fact, we have taken decreases in diapers, baby food, laundry soap and paper products," he

public opinion, was effective in urging the House to re-

2002. The transport projects – using what are kn as GARVEE

to the Senate Finance Co
Finally, despite wha

Spill...

Continued from Page 1

Chenega Bay, is part of a crew of eight working on this stretch of shoreline at Snug Harbor. Crews are spending the summer searching for oil that remains from the Exxon Valdez spill more than a dozen years ago.

"There's no rocket science to finding it," said Jeff Short, a research chemist with the National Marine Fisheries Service, the agency conducting the shoreline survey.

Human efforts in the years immediately following the spill, as well as tidal action and storms, have washed away much of the oil, and the sound has largely recovered. But pockets of pollution remain.

"It's been a big surprise," Short said. "Most people, including us, would have thought it would be gone by now."

The last time Prince William Sound beaches were surveyed for surface oil was in 1993. While that type of on-the-ground survey was helpful in assessing the need for cleanup, it was not useful in producing an estimate of the oil remaining in the sound, Short said.

Snug Harbor is 55 miles southwest of Bligh Reef, where the Exxon Valdez ran aground, gushing 11 million gallons of crude oil into the waters of Prince William Sound on March 24, 1989.

A 1994 study by the fisheries service estimated that about 70 percent of the spilled oil had evaporated into the air or biodegraded in the ocean or on shore, and 14 percent had been recovered through cleanup efforts.

About 13 percent – 1.4 million gallons – was estimated to remain in the mud, sand and sediments in the Gulf of Alaska and Prince William Sound. About 2 percent, or 217,000 gallons, was thought to remain on beaches. Short describes that study as an educated guess, based upon the behavior of oil.

Back at Snug Harbor as the water laps the shore in this quiet cove, the environmental that blanketed beaches and killed thousands of b marine mammals seems away.

But as the workers mo the beach with shovels a they find spots where soaked into the sand. The backbreaking, time-co and tedious, and the crew long days, the hours dic the tides.

"Some beaches are ea others," said Mandy Li the field chief supervising ect.

Just a few days ear about 18 miles north of crew scrambled over we boulders in the shadow o spruce forest at Northwe Eleanor Island. The be idyllic, but tiny black gl oil can be found under r floating in the tidal pools.

"It's really the topogr dictates how long the oil i stay," said Lindeberg.

As of mid-June, the

...known as GARVEE ... the Senate Finance Committee. Finally, despite ... James ... that he couldn't get both that and the transportation package, ... Bill McAllister can be ... at billm@juneauempire.com.

...was in 1993. While that ...he- ...d survey was ...issessing the need for ...was not useful in pro- ...estimate of the oil re- ...the sound, Short said. ...rbor is 55 miles south- ...igh Reef, where the ...lez ran aground, gush- ...on gallons of crude oil ...ters of Prince William ...arch 24, 1989.

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...3 percent – 1.4 million ...as estimated to remain ...sand and sediments in ...f Alaska and Prince ...ind. About 2 percent, or ...ons, was thought to re- ...eaches. Short describes ...as an educated guess, ...the behavior of oil.

...ug Harbor has the wa- ...e shore in this quiet cove, the environmental disaster that blanketed beaches with oil and killed thousands of birds and marine mammals seems a world away.

But as the workers move across the beach with shovels and picks they find spots where oil has soaked into the sand. The work is backbreaking, time-consuming and tedious, and the crew puts in long days, the hours dictated by the tides.

"Some beaches are easier than others," said Mandy Lindeberg, the field chief supervising the project.

Just a few days earlier and about 18 miles north of here, the crew scrambled over wet, mossy boulders in the shadow of a dense spruce forest at Northwest Bay on Eleanor Island. The beach looks idyllic, but tiny black globules of oil can be found under rocks and floating in the tidal pools.

"It's really the topography that dictates how long the oil is going to stay," said Lindeberg.

As of mid-June the crew had dug about 2,500 pits on randomly selected beaches oiled by the spill. By the end of summer about 8,000 pits will have been dug and examined for oil.

The workers have encountered oil about 8 percent of the time on beaches that had been heavily oiled, Short said. Whenever the workers find oil, they map the size and location of the oil patch. The amount of oil will be estimated by sampling.

From that information, Short will estimate the oil remaining in Prince William Sound, without having to examine all of the beaches. He expects his study to be completed in about a year.

Any oil found would have a 90 percent chance of having come from the Exxon Valdez, Short said.

Exxon Mobil Corp. spokesman Tom Cirigliano would not comment on the study, but he said Exxon worked on cleaning up the oil until state and federal officials called a halt.

"There were certain areas of Prince William Sound that the state and the federal governments determined that no further cleaning should take place because the cleaning would cause more harm to the environment than the natural cleaning of oil," Cirigliano said.

"Of course there are places in Prince William Sound where, if you look hard enough, you can find Valdez oil," he said.

Fisheries service officials say the amount of oil found so far is not likely to have detectable effects on fish or wildlife. But an estimate of the amount of pollution that remains will help resource managers and scientists decide if further study or monitoring is needed.

From: Phil Mundy [phil_mundy@oilspill.state.ak.us]
Sent: Monday, July 09, 2001 2:09 PM
To: Spies@Amarine.Com (E-mail); McCammon, Molly (E-mail)
Subject: FYI Gary Thomas

Study finds Stellers ignore pollock
NATURE: Fishing industry stirred by reports that endangered sea lions prefer herring over restricted fish.

By Wesley Loy
Anchorage Daily News

(Published July 7, 2001)
Alaska's endangered Steller sea lions feast on herring but ignore more abundant pollock, according to a study detailed in the June 28 issue of the respected British science journal Nature.
The study is of great interest to Alaska's $700 million pollock industry, which federal regulators have restricted to protect sea lions. Some scientists theorize the Stellers might be losing a competition with fishing boats for food.
The abundant, bland, white-fleshed fish targeted in Alaska's most valuable fishery are used to produce fast-food fish portions and a versatile protein paste called surimi.
The study by Gary L. Thomas and Richard E. Thorne of the Prince William Sound Science Center in Cordova combined sonar surveys of Pacific herring and walleye pollock with infrared scanning of foraging sea lions.
The goal was to observe prey abundance and sea lion feeding habits. Such studies are lacking, according to the authors.
According to the brief article in Nature, sea lions were surveyed with sonar and infrared scans during March 2000 in Prince William Sound, including the important herring hangout of Rocky Bay at Montague Island.
"Despite the much greater abundance of pollock, the infrared system revealed that foraging by Steller sea lions was exclusively on herring and was conducted only at night," according to the article. "Foraging activity was intense on dense herring schools. Steller sea lions were often observed swimming side by side in a row of 50 or more individuals along the edges of a school, suggesting that they were herding the herring."
The article said herring tended to stay closer to the surface at night and deeper during the day, while pollock stayed deep all the time. Though Stellers can dive to the pollock, the herring are more accessible at night, and that might explain the foraging behavior of sea lions.
"Our results indicate that the dependence of Steller sea lions on herring as prey has been underestimated," the article concluded.
Scientists are not certain whether competition with fishing boats or ocean climate shifts are to blame for the steep decline in Stellers across Western Alaska, including in the Sound. Some suggest pollock are not as nutritious for sea lions as more oily fish such as herring and capelin.
The herring population is at a historic low in Prince William Sound and has not been harvested commercially since 1998, Thorne said Friday in an interview.
Thorne, a senior scientist at the independent, nonprofit center and a University of Washington faculty affiliate, said no fishing industry money was used in the study. Rather, he said, funding came from the Prince William Sound Oil Spill Recovery Institute, which was authorized by the federal Oil Pollution Act of 1990.
Thorne said the study doesn't get the fishing industry off the hook for the sea lion decline. However, it does raise questions about the relative role of pollock in the Stellers' diet and whether curtailing the pollock fishery is the right step, he said.
Reporter Wesley Loy can be reached at wloy@adn.com <mailto:wloy@adn.com> or 907 257-4590.

EIGHT-ARMED RESEARCH

Studying Alaska's elusive *Octopus*

Scientists search waters for secretive cephalopod

By DOUG O'HARRA
Anchorage Daily News

Just where would a shrewd, boneless predator with keen eyesight, eight arms and 2,240 suckers hole up during low tide?

Carrying a driftwood spear for probing the lair of the world's craftiest mollusk, biologist David Scheel squinted under his floppy hat and scanned a broad beach of boulders and drippy kelp near Port Graham on the far side of Kachemak Bay.

"I know one of these rocks had an octopus under it," Scheel said. "I just can't remember which one it was."

Octopuses aren't supposed to live so high on the beach. But years earlier, a local Native hunter had shown Scheel a den used by what the Alutiiq people call *Amikug*. The scientist eased his stick into one promising hollow where boulder met mud, cocking his head as he gauged for a response.

"An octopus is the only thing that will shove the stick back out or play with it a little bit," he said.

But no one was home. Not yet.

Over the past six years, Scheel has pushed the boundaries of what's known about the giant Pacific octopus in Alaska, documenting for the first time where it lives and what it likes to eat in Prince

See Page A-8, OCTOPUS

Scheel closely studies a clam shell. He is looking for the telltale markings of a "drill" from an octopus.

William Sound and lower Cook Inlet. Among other things, he and his co-researchers found that local octopuses often prefer the dry-now, submerged-later intertidal zone, contradicting a long-held assumption that the species sticks to deep water. It's a strategy that might keep them from becoming chewy snacks for sea otters.

Yet much about the weird, mythic creature remains an enigma no one knows why population levels seem to be declining, for instance, or how they might be accurately monitored by people.

"What I'm trying to learn is what regulates the number of octopus," Scheel said. Is it habitat? Food supply? Birth rate? Predation?

Following his first year as assistant professor at Alaska Pacific University's new marine science program, Scheel returned to Kachemak Bay for a few weeks at the end of May with his wife, plant ecologist Tania Vincent, his young daughter and APU senior Peter Plywaczewski to search for more answers.

He didn't have far to look.

'A BEAUTIFUL LITTLE ANIMAL'

Scheel and Plywaczewski (nicknamed "Crazy Pete" for enthusiastic habits like tide-pooling in bare-toed sandals) walked the beach, uncovering craggy boulders and searching tide pools. At first they found only collapsing sea anemones and squadrons of tiny scrambling crabs. In a couple of places, they found potential octopus food — clams, crabs, chitons, limpets, snails and other tiny animals.

Then Scheel stooped by a little cavern rimmed with sand and a midden of fresh shells — a place that would usually go dry during the ebb. Some of the shells contained hairline slits, an indication that some octopus had "drilled" them with a special organ called a radula, then softened the inner tissue with enzymes from its saliva. Other shells appeared to have been crunched open by an octopus' hard beak, then scoured clean.

Scheel probed the hole with the stick.

Something grabbed on.

"Oh yeah," he said.

A few moments later, after the tide had risen a few more inches, Scheel blew a skin irritant of diluted chlorine into the hole through a plastic tube. Seconds later, a giant Pacific octopus began to ooze into view, one arm at a time.

Soon Scheel would be scooping it up in his palms and slipping it into a mesh bag, where the animal would collapse into a wad the size of a volleyball. He would wash it, measure its mantle and the distance between eyes. The 2½-pound female was about a year old, with eight healthy limbs and a taste for tiny crabs. When released, it would fast disappear into the kelp, shifting the mottled red of its skin, chameleonlike, to match the background.

But for a moment, Scheel and Plywaczewski just watched.

Festooned with about 280 oval suckers, the first reddish arm unraveled from the hole in an eely sine wave. Another arm unrolled to the right, then another to the left.

Like the fingers of a climber blindly exploring a rock face for a place to grip, the flexible arms seemed to pat down the floor of the pool, probably "tasting" out an escape route with its suckers, each far more sensitive than a human tongue. Then they clamped down. In a smooth motion, the octopus' main body slipped into the open, its inscrutable eyes narrowed to slits. All eight legs spread out, like the rays of a star. It was launched, moving fast toward the open sea.

"What a beautiful little animal," Scheel said.

Then he snatched it from the pool.

FINDING A HOME

Long a source of subsistence food for Alaska Natives and an important player in near-shore ecology, giant Pacific octopuses have rarely been studied in Alaska. They're rarely harvested commercially in local waters. No one has population numbers or a full understanding of their life cycle.

That began to change in 1995. At the urging of several Native leaders concerned that the octopuses seemed more scarce since the Exxon Valdez oil spill, the oil spill trustees council invited proposals to investigate the status of octopuses in the Sound and other local waters. Scheel, then working at the Prince William Sound Science Center, applied for the grant.

By then, Scheel had already pursued an eclectic career. At the University of Minnesota, Scheel studied behavior of African lions in the Serengeti and later worked on mammals in Texas and Geographic Information System analysis in ecological studies. Vincent, an expert on prairie plant communities, often worked with him.

With about $225,000 in funding from the trustees, Scheel organized a 15-member team that spent two seasons searching for octopuses at dozens of locations throughout Prince William Sound and Kachemak Bay. They looked under rocks and sent divers down to nearly 100 feet. They even used a minisub to track them. No one had ever done such research in Alaska before, Scheel said.

"We'd mark on dens with street address numbers, glued on with epoxy," Scheel said.

They tracked five octopuses with sonic tags to see where they went. They cataloged what they ate — a wide range of crabs, bivalves and chitons. Octopus parts were found in the stomachs of 43 fish species, particular dogfish sharks. Sea otters and harbor seals ate them, too.

Scheel also worked with Native foragers and fishermen from Tatitlek, Chenega Bay and Port Graham, going into the field and listening to their instructions about octopus habitat and behavior.

Conventional octopus wisdom states that the creatures stay deep and get bigger as you go down. But Scheel's team found that local octopus seemed to prefer intertidal mud beaches and dense kelp beds, possibly to avoid predators. About 80 percent of octopuses were found in less than 15 feet of water.

"They really do use the intertidal," Scheel said. "And I think they live in it — they're not just there incidentally."

But the team was unable to explain why the species might be declining throughout its Pacific Rim range. One theory hinged on sea otters, present in Prince William Sound but absent from British Columbia.

"We think that intertidal habitats in the Sound provide refuge from sea-otter predation," Scheel and his co-authors wrote. "Octopuses here may be limited in distribution to depths where otters do not forage."

Scheel and Vincent have adopted the species. At home, they have octopus pictures, refrigerator magnets. Their 2½-year-old daughter, Juniper (herself a budding biologist who knows the proper names for many animals) "has more-than-she-can-count stuffed octopuses," Scheel said.

Octopuses fascinate Scheel, partly because of their position in the middle of the food chain intelligent and adaptive creatures that live as both predator and prey.

UNKNOWN ANSWERS

On the May trip to Kachemak Bay, Scheel brought a hand-picked research team: bare-toed "Crazy Pete," Vincent (who has become an expert in identifying octopus cuisine) and Juniper, who loves octopuses as much as her parents. When one octopus wrapped an arm around her leg, she wasn't alarmed, Scheel said. "She said, 'It's hugging me!' "

During the first four days, Scheel caught six octopuses with crab pots in deep water, partly as a test for a future experiment. If he could get funding, Scheel would come back next year, catch octopuses deep and release them shallow with tags that emit a sound.

"Then we'll follow them with the submersible and see where they go," he said. "Nobody's ever done it before, and I've been saying for years we should just switch some and see what happens."

Though Scheel proved he could find octopuses deep, it didn't always go smoothly. One 65-pounder trapped about 200 feet down in Eldred Passage emerged from the pot and "fought like a mad man," Scheel said.

Its arms whipped out, suckering the deck and grabbing rails and wrapping around human legs.

"You pull them up like a bath mat," Scheel said. "You pull them up one sucker at a time, and that works great except that they have eight legs and you have only two."

The two men wrestled the octopus into the pot so they could they could return it to the water. "When they get that big, they're pretty strong," Scheel said. "But they tire easily" due to copper-based blood that's not as efficient as the iron-based blood of mammals.

On most mornings, Scheel and Plywaczewski towed a fine-mesh net behind the 27-foot Islander with Capt. Bruce Lozekar at the wheel. Intended to sample the top few centimeters of ocean surface for plankton, the results from the tows were bottled and examined each night under the microscope. In theory, Scheel would find a smattering of tiny baby octopuses among the copepods, crab larvae and other creatures.

So far no octopuses.

"Could mean the season is wrong," Scheel said. "Could mean I'm towing in the wrong places. Could even mean I'm towing at the wrong depth. It's not that well established, that octopuses hang out at the surface."

But that's OK, Scheel said.

"It's no fun doing research if the answers are all known already."

'SHOULD I ... EAT IT?'

It was almost like a family outing. Scheel carried Juniper on his shoulders. Vincent and Plywaczewski (in the role of Sherpa-student) hoisted buckets of scientific equipment and supplies.

The goal was a rock pile on the outside coast of McDonald Spit, located about six miles east of Seldovia Bay, a two-mile walk from Baxter Laboratory, where Scheel and his team had been staying.

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Eventually Vincent and the child fell behind, while Scheel and Plywaczewski had to rush ahead to meet low tide. Once they crossed the tidal shallows to the exposed reef of rocks, it took only a few minutes for Scheel to find a certain pool that he knew contained an octopus den, nestled above the beach in a craggy hollow.

"OK, OK, OK, OK," the scientist exclaimed. "There it is."

Sheltered from the sea by a barnacle-encrusted wall, the pool seemed like a snug refuge for an octopus. It contained stinging anemones, leather chitons, limpets, tube worms.

Wearing gloves, Scheel stooped and began collecting the remnants of the octopus's dinner. Suddenly he realized the creature had scooted into the den's mouth.

"He's checking me out," Scheel said.

"He's saying, 'There's something in my pool. I wonder if I should come out and eat it?' "

One arm emerged and grasped Scheel's finger and tried to pull him into the den. "This is a sweet little octopus," the scientist said, delighted. "I like them when they come out to say hello."

Scheel and Plywaczewski collected the discarded shells, blew the irritant into the hole, carried the emerging octopus down to a broad pool. It was a female, almost 4 pounds, with healthy arms and a nice splotchy red color. They released it and watched it slide under kelp.

"All right, that was the easy one — we knew where she was," Scheel said. "Let's search these rocks for other dens."

Scheel and Plywaczewski spread out — crisscrossing the shallows, scrambling through the rocks, peering under mats of slippery seaweed. Several potential dens seemed empty. An octopus inside one den just wouldn't emerge.

By then, Scheel's wife and daughter had arrived, and the tide was beginning to rise. Scheel and Vincent decided to try one final den, partly blocked by a glistening sunflower star — a huge starfish with 26 rays. After dragging the creature out of the way, Scheel found a big one.

A large mottled octopus slithered from the hole, moving fast toward the rising tide.

"There we go that one's bigger than the last one," Scheel exclaimed as he scooped it up.

The creature, also a healthy female, weighed nearly 9 pounds, with glistening suckers and bulging arms that spanned 4 to 6 feet. After Scheel and Plywaczewski recorded the data, they set the octopus in the bag in the pool.

"Does that one do?" Juniper asked her father.

"Does that one want to hold hands?" Scheel replied. "Let's see."

The little girl lightly brushed her fingers against one of the folded arms. A sucker latched on, and she began to laugh.

"He's got a hold of my finger," she cried. "AH! He got me!"

"He's got you," Scheel said. "Should we let him go, Juby?"

"No, one more time."

For a moment, the octopus held the girl's finger, probably tasting it. Then Scheel eased the animal into a tide pool.

It spread out, reaching with its arms, pulling its mantle along like a great bag. At one point, it backed up against rocks, raising its mantle from the water, staring at the humans with narrow, unreadable eyes.

"See, she's looking at us," Scheel told his daughter.

Then the octopus submerged. The tide was rising fast. In moments, the octopus oozed under a wad of kelp, out of sight, back in its undersea world.

■ Doug O'Harra can be reached at do'harra@adn.com and 257-4334.

Scientists surprised at how much oil remains years after the Exxon Valdez spill

Crude awakening

By DOUG O'HARRA
Anchorage Daily News

BAY OF ISLES, PRINCE WILLIAM SOUND — With blue mussels and seaweed still glistening from the falling tide, Tatitlek resident Wayne McDonald began digging a hole in the gravel on the shore of Knight Island.

Would there be oil? And how thick?

McDonald was part of a crew trying to find out how much Exxon Valdez crude remains a dozen years after the tanker dumped 11 million gallons into the Sound. As the young man continued loading muck into a plastic tote, several federal scientists stood by to sample for chemical tests.

This particular spot didn't look polluted. Located between the bay and a peat bog nicknamed "Death Marsh" in 1989 because of the way it concentrated spilled oil, the rocky shore was littered with driftwood and pieces of old net, pelted by summer rain and serenaded by cackling ravens.

A week ago, it seemed as pristine as any stretch of beach along the wilderness island about 100 miles southeast of Anchorage.

That impression changed as McDonald dug deeper.

"We're getting into oil already," exclaimed Mandy Lindeberg, field chief from Auke Bay Laboratory of the National Marine Fisheries Service. "Sheen! You see the sheen. It's got that shiny look to it."

The rainbow of liquid oil swirled in the hole. It generated a raw petroleum odor reminiscent of a truck yard, suggesting that this small pocket of hidden crude remained nearly as volatile as it did when it washed ashore.

"It's chemically not very different," said federal chemist Jeff Short, a principal investigator on the project. "I think it's going to be here for decades."

"It's there," Lindeberg added. "And it's not going away."

In a project funded by the Exxon Valdez Oil Spill State/Federal Trustee Council, a

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team has been spending the summer surveying some of the most oiled beaches by digging more than 8,000 pits at randomly selected locations. The council is a joint agency that manages the billions of dollars collected from Exxon through the courts, spending the money primarily on restoration, habitat and scientific study.

With the project just more than half done, the team has found oil seven to eight times more often than expected, according to the federal scientists coordinating the work.

Of 4,428 pits dug or surveyed on more than 50 beaches through July 6, about 450 contained surface or subsurface oil, Short said.

"I would have thought that it would have been hard to find at this point," said Stanley "Jeep" Rice, a supervisor at the Juneau-based lab. "But it's been easy to find. We've been finding it routinely."

The results have dismayed some field workers who live in communities around the Sound and have been hired to dig the pits and take samples through local Native corporations.

"I didn't think that we would come into this much oil," said William Evanoff, a resident of Chenega Bay on Evans Island and a former spill cleanup worker. "My impression was we were not going to find anything."

Most beaches at first appear pristine, with clean cobble, intertidal zone awash in seaweed and mussels, air fresh with aroma of surf and forest.

"But when you start digging, that's when you see it," Evanoff said. "You don't really see the gooey stuff until you get down about 15 centimeters," about 6 inches.

Once completed in 2002, the $572,000 project will produce the first comprehensive estimate of how much oil persists in the Sound's intertidal sediments, according to Short. It's being coordinated by the Auke Bay Lab of the Alaska Fisheries Science Center in Juneau with help from the Bureau of Economic Geography at the University of Texas.

The information could figure into whether the trustees demand additional cleanup from Exxon after 2002, and it would give fishermen and residents a measurement of what's really out there, how fast it's declining and how it has been migrating through sediments.

Previous estimates on what happened to the oil were based largely on scientific models or anecdotes, Short said.

The study design is complex. Samples will be taken from beaches that remained oiled in the early 1990s, then correlated with height above low tide and other features on the beach. When oil is found, the crew will dig additional pits to define the size of the patch, then sample the patches for lab tests.

"This is very hard to do," Short said. "It has never been done before."

The long-term fate of Exxon Valdez oil has often been controversial. Exxon and its scientists have long maintained that the Sound has basically recovered from the spill and that any remaining oil is isolated in small pockets that have little or no impact on life.

While the remaining oil doesn't effect overall populations of animals in the Sound, local effects — the mussels on a specific beach, salmon fry in a certain stream — could still be damaged, Short argued.

"If a winter storm were to come in or a log were to disturb it, all this oil would be in the food chain again," said Lindeberg, the Juneau lab official.

When the scientists were designing the study, Short said, they worried that oil would be so sparse that random samples might not generate enough data to let them make valid estimates. For the study, they hoped to find oil at least 1 percent of the time, in 80 pits out of 8,000.

Working from the 72-foot boat Kittiwake II, the seven-member crew began work on May 7 by digging 78 pits in a 290-foot span of beach in Northwest Bay on Eleanor Island. They found oil in 41 pits, a rate of 53 percent.

"When we were done, we left an oil slick on the water, a sheen that looked like you'd pumped the bilge of a fairly large and dirty boat," Short said.

Since then, findings have ranged widely as they moved among a dozen islands and three-score beaches, coming ashore with shovels on a schedule dictated by the ebbing tide. Pits on a dozen beaches had no oil at all. Half a dozen beaches produced results almost as bad as Northwest Bay.

On the morning that they worked in the Bay of Isles and Death Marsh, the crew found oil in four pits out of 72.

"It wasn't as oiled as I had expected," said Pat Harris, a federal scientist who has been studying the effects of the spill since days after it occurred in 1989.

"We found a band (of oil) that went across 33 meters by 8 meters," Lindeberg added. "It was very deep and dark. It smelled, and it sheened too."

What makes this study more important is the random selection of the pits, Harris said. "We're just digging where the random (calculation) tells us, and we find it. It kind of gives the study more power, because these sites aren't selected" for surface appearance.

"You always have mixed emotions when you find it," she added. "On one hand, it's good for the project. On the other hand, it's discouraging."

■ Doug O'Harra can be reached at do'harra@adn.com and 257-4334.

ANCHORAGE DAILY NEWS
SUNDAY, JULY 22, 2001

Council disregards those opposed to land acquisitions

Exxon Valdez Oil Spill Trustee Council, an organization formed after the oil spill of 1989, is compoised of three state and three federal agencies, and, has millions of dollars. After attending numerous meetings, I come to the conclusion that EVOS' sole intent is to acquire all lands possible with no respect and regard to the people who are affected and oppose these land acquisitions.

EVOS is in final negotiation to acquire 1,860 acres in the Village of Karluk. These 1,860 acres were conveyed from our regional corporation to our village corporation with the intent to disperse 10 acres to the original 186 members of Karluk. Unfortunately we have a council that refuses to acknowledge and represent the 186 members. Majority members of Karluk have submitted their opposition to EVOS; EVOS' intent to acquire our lands remains.

Does EVOS care about taking our lands away from us, our homes, our culture, and the future of our children? How does oil money justify acquiring Native lands? Is this a system in which the state of Alaska and the U.S. government will eventually own all the land? I continue to ask my senators, congressmen, governor and state representatives for help.

— Chuck Reft, Anchorage
Sandra Vinberg, Kodiak
Members of Karluk

Whales in Sound imperiled

■ ORCAS: Poisons may be driving unique family to extinction.

By **DOUG O'HARRA**
Anchorage Daily News

A well-known killer whale that stranded and died last summer outside Cordova was carrying high levels of industrial poisons in its body, offering yet more evidence that pollutants produced thousands of miles away continue to accumulate at the top of Alaska's marine food chain.

These chemicals may now be another factor pushing a genetically unique family of Prince William Sound whales, known as the AT1 group, closer to extinction, according to local whale biologists and environmentalists.

"It's more of the same bad news," said biologist Craig Matkin, of the North Gulf Oceanic Society and the region's leading killer whale researcher.

The contaminants found in the dead whale were PCBs, or polychlorinated biphenyls, and the pesticide DDT, chemicals banned or restricted in the United States for decades but still produced in some Asian and Third World countries.

Transported across the globe on air and ocean currents, the contaminants infiltrated Alaska's food chain and have been documented at elevated levels in a wide range of animals for years — sea otters, seals, walruses, peregrine falcons, northern fur seals and bald eagles. As the chemicals move up the food chain, they concentrate and build in fatty tissues.

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As a result, among 77 killer whales tested in the Gulf of Alaska between 1994 and 1999, the highest levels appeared among animals that eat only marine mammals, the type known as transients. Among 10 killer whales sampled in 1999 and 2000, several transients appear to be among the most contaminated marine mammals ever measured.

The whale that died last July in Hartney Bay — a closely studied harbor seal predator nicknamed Eyak — had concentrated PCPs at about 370 parts per million and DDTs at about 470 parts per million in its tissues, according to chemist Gina Ylitalo, of the National Marine Fisheries Service's contaminants lab in Seattle.

Another transient male from the Gulf of Alaska had the highest levels ever measured in Alaska waters — about 651 parts per million PCBs and about 1,003 parts per million DDTs, according to Matkin's report. That whale, unrelated to the Sound's AT1 group, had a dorsal fin that was bent over, a sign of ailing health among killer whales.

The results were released this spring as part of an annual report by Matkin and four other authors on the status of the Sound's killer whales for the state-federal Exxon Valdez Oil Spill Trustee Council.

Similar levels found recently in killer whales in the Pacific Northwest prompted leading biologist Peter Ross and four others to write in Marine Pollution Bulletin that "killer whales in British Columbia can now be considered among the most contaminated cetaceans in the world."

By comparison, the U.S. Food and Drug Administration standard for PCBs in fish for human consumption is 2 parts per million and the limit for DDTs is 5 parts per million.

Scientists don't know how the substances affect the long-lived, slow-reproducing killer whales. Whether such elevated levels contributed directly to the death of the 5-ton, 24-foot whale isn't known, Matkin cautioned. "We will probably never know the cause of death."

But comparable contaminant loads have been linked to reproductive failures in beluga whales of the industrialized St. Lawrence River estuary, die-offs of striped dolphins in the Mediterranean Sea and European harbor seals.

"It's clearly in the range of potential health risks," Matkin said. "It's scary stuff."

Whatever the cause, the death of Eyak furthered the decline of the AT1 group, an extended family of whales that lost 11 of 22 members in the three years after the Exxon Valdez oil spill. These whales, which have never been seen associating with other transients in the region, have not produced any offspring since before the spill.

"The upshot is that they're disappearing so fast that I don't know what we can do for them," Matkin said. "We've been debating about whether to try to get them listed under the Endangered Species Act."

Another transient whale was found dead June 25 near Johnstone Point on Hinchinbrook Island west of Cordova, an area historically used by Eyak and other AT1 whales, especially a slightly older male known as Eccles. Eyak and Eccles, named for mountains overlooking Orca Inlet near Cordova, often hunted seals together and were well known to people in the Sound.

By the time Matkin and others reached the whale to perform a necropsy in early July, the whale had begun to decompose, making it impossible to identify the animal from its markings. Tests to establish the whale's genetic background and contaminant levels haven't been completed yet, Matkin said. "But I have a bad feeling that this is one of the AT1s."

That would reduce the local group of transients to 9 — a loss of 13 whales in 12 years, a decline never before documented among killer whales in the North Pacific.

"They're going away," said Donna Willoya, research director for the Alaska Sea Otter & Stellar Sea Lion Commission who helped Matkin perform the necropsy. "It's like a family that's dying off."

That dead whale had a belly full of seal parts and, strangely, pieces of bull kelp, Matkin said. There was no obvious cause of death.

"This looked like a healthy animal," added Willoya, who also responded to the whale death last year. "This one actually had better teeth than Eyak."

The AT1 group's ongoing problems have worried local residents. The presence of the contaminants at such high levels in the whale is especially alarming, said Kate Williams, director of environmental programs for the Native Village of Eyak. "The concern is huge."

Pat Lavin, coordinator of the Prince William Sound Alliance for the National Wildlife Federation, likened these local whales to a marine "canary in the mine."

"We see the AT1 whales and their difficulties as indicative that the ecosystem is suffering," he said. "We have a pod of killer whales that's basically on the verge of extinction, and I don't think people know that. We're definitely planning to do all we can to prevent that extinction from happening and, if it's unavoidable, to learn all we can from it."

The overall situation for three separate types of killer whales in the eastern North Pacific Ocean is complex, with some pods increasing and others in decline. For instance, the Sound's famous AB pod of resident whales has declined overall from 36 to 25 between 1988 and 2000 and is still not considered recovered from the oil spill by the Trustee Council. The number of other known Gulf of Alaska resident whales increased from 81 to 110 during the same period.

Complicating the picture even more is that biologists are still debating whether certain troubled groups of whales live independently as distinct stocks — often a legal requirement for special federal protection — or whether they're really part of larger populations.

The issue has been raised by a petition from environmental groups to list the Southern Residents, a population of fish-eating whales that frequent Puget Sound, under the Endangered Species Act. The National Marine Fisheries Service has not responded to the petition yet, according to biologist Robyn Angliss, assistant to the director of the Marine Mammal Laboratory in Seattle.

The same question would arise if someone proposed listing the AT1 whales, Angliss said. The agency officially includes the group as part of the Eastern North Pacific Transient stock, a population of 346 animals ranging from the Bering Sea to the Pacific Northwest.

Years of genetic testing and observation by Matkin and his associates suggest that the AT1 whales have been isolated from other transients in the region for generations. They have their own habits and appearance.

"These AT1s, they have a very unique vocal repertoire," Matkin said. "They're almost like sirens, these calls they give under water."

Unlike the noisy, gregarious pods of salmon seekers, transient killer whales stalk marine mammals in small groups, guided by a social structure that's not well understood. Among these mysterious animals, the AT1 group was once remarkably predictable. Matkin's team usually identified all 22 whales in the Sound and Kenai Fjords region every season between 1984 and 1989.

But days after the Exxon Valdez grounded on Bligh Reef and dumped 11 million gallons of oil into the Sound, several AT1 whales were photographed swimming through a slick. Two disappeared that year, seven in 1990, two more by 1992. Matkin believes those whales are dead.

The group's inability to rebound during the past decade might stem from multiple causes — the oil spill taking important members, rising contaminant levels in their bodies, and the regional crash of the favorite prey, the harbor seal.

"It's extremely upsetting," Matkin said. "As far as trying to do something for these animals, it just feels like the current against them is so strong."

Still, it's unclear what the government could do exactly to protect killer whales if they were given additional legal protection, Angliss said.

When Eyak died last summer, the whale was believed to be at least 32 years old — a relatively old male. "But there are a lot of males that live a lot longer than that," Matkin said.

The whale had been eating well. In its stomach were harbor seal chunks and claws and hair, along with a tag from a seal caught and released in Port Chalmers of Montague Island and one from a seal caught at Applegate Rock in Montague Strait.

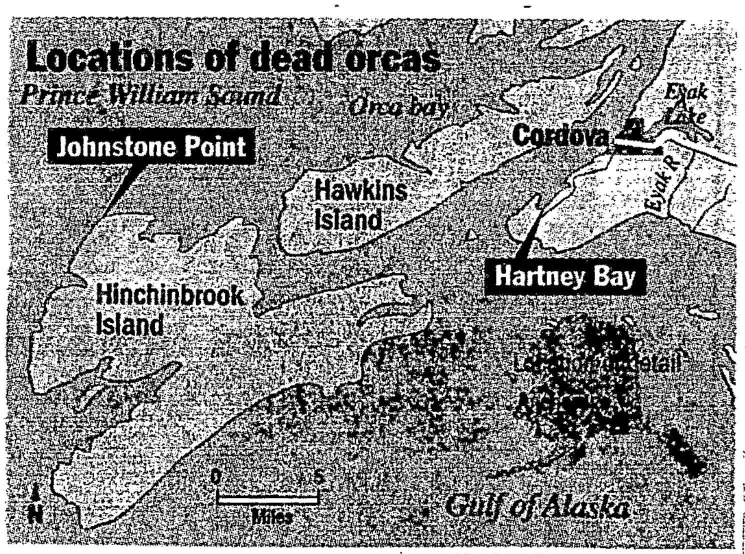
A team of volunteers from the Prince William Sound Science Center, the Native Village of Eyak and the U.S. Forest Service salvaged the whale's remains in a project to rebuild the animal's skeleton. That project is still under way, said Aaron Lang, education coordinator for the science center.

The bones were sunk in crab pots over the winter, he added. "The sea critters did their job and ate a bunch of flesh off them." The bones are still being processed.

"We're trying to figure out the best way to approach the rearticulation," Lang said. "I think there are only three or four intact orca skeletons in the world, so it's not a process that's been done very much."

In the aftermath of Eyak's death, Matkin said, he received reports that Eccles, Eyak's longtime hunting companion, was visiting former haunts in the eastern Sound. "He was wandering around by himself all late summer," Matkin said. "It was a sad deal."

■ Reach Doug O'Harra at 257-4334 or lo'harra@adn.com.



CHARLES ATKINS / Anchorage Daily News

RESOLUTION OF THE *EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL REGARDING VALDEZ DUCK FLATS SMALL PARCEL PWS 06

We, the undersigned, duly authorized members of the *Exxon Valdez* Oil Spill (EVOS) Trustee Council (Council), after extensive review and after consideration of the views of the public, find as follows:

1. On December 4, 2000, the Council resolved to provide funds for the State of Alaska to purchase all of the seller's rights and interests in the small parcel PWS 06, consisting of 24.68 acres, and to provide funds necessary for closing costs recommended by the Executive Director of the Council (Executive Director) and approved by the Council, subject to certain conditions. One of the conditions was that a purchase agreement had to be executed by June 21, 2001. The seller is the University of Alaska (University).

2. Although the University has agreed to sell the land to the State for the price in the Council's resolution of December 4, 2000 ($100,000) and the State expects to be able to complete the acquisition, a purchase agreement was not executed prior to June 21, 2001 as required by the Council's December 4, 2000 resolution.

3. For all of the reasons detailed in the Council's resolution of December 4, 2000, the Council continues to find that the purchase of PWS 06 is an appropriate means to restore a portion of the injured resources and services in the spill area.

THEREFORE, we resolve to provide funds for the United States to purchase all of the seller's rights and interests in the small parcel PWS 06 and to provide funds necessary for closing costs recommended by the Executive Director and approved by the Council, pursuant to the following conditions:

(A) the amount of funds to be provided by the Trustee Council to the State of Alaska or the United States shall be one hundred thousand dollars ($100,000) for small parcel PWS 06;

(B) authorization for funding for any acquisition described in the foregoing paragraph shall terminate if a purchase agreement is not executed by September 1, 2002;

(C) completion of a title search satisfactory to the State of Alaska and the United States and the seller is willing and able to convey fee simple title by a deed acceptable to the State of Alaska;

(D) no timber harvest, road development or alteration of the land will be initiated by the seller prior to the purchase without the express agreement of the State of Alaska and the United States;

(E) completion of a hazardous materials survey satisfactory to the State of Alaska and the United States;

(F) compliance with the National Environmental Policy Act; and

(G) a conservation easement on parcel PWS 06, satisfactory in form and substance to the United States and the State of Alaska Department of Law, shall be conveyed by the seller to the United States.

It is the intent of the Council that, except as described below, any facilities or other development on the foregoing small parcel shall be of limited impact and in keeping with the goals of restoration and that there shall be no commercial timber harvest nor any other commercial use of the small parcel except such limited commercial use as may be consistent with applicable state or federal law and the goals of restoration to pre-spill conditions of any natural resource injured, lost or destroyed as a result of the EVOS and the services provided by that resource or replacement or substitution for the injured, lost or destroyed resources and affected resources as described in the Memorandum of Agreement and Consent Decree between the United States and the State of Alaska entered August 28, 1991 and the Restoration Plan approved by the Council.

By unanimous consent, following execution of the purchase agreement between the seller and the State of Alaska and written notice from the Executive Director that the terms and conditions set forth herein and the purchase agreement have been satisfied, we request the Alaska Department of Law and the Assistant Attorney General of the Environment and Natural Resources Division of the United States Department of Justice to take such steps as may be necessary for withdrawal of the purchase price for the above-referenced parcel from the appropriate account designated by the Executive Director.

Such amount represents the only amount due under this resolution to the sellers by the State of Alaska to be funded from the joint trust funds, and no additional amounts or interest are herein authorized to be paid to the sellers from such joint funds.

Approved by the Council at its meeting of August 6, 2001 held in Anchorage, Alaska, as affirmed by our signatures affixed below:

DAVE GIBBONS
Supervisor, Chugach National Forest
USDA Forest Service

CRAIG TILLERY
Assistant Attorney General
State of Alaska

DAVID B. ALLEN
Alaska Regional Director,
U.S. Fish and Wildlife Service
U.S. Department of the Interior

JAMES BALSIGER
Director, Alaska Region
National Marine Fisheries Service

FRANK RUE
Commissioner
Alaska Department of
Fish and Game

MICHELE BROWN
Commissioner
Alaska Department of
Environmental Conservation

RESOLUTION OF THE
EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
REGARDING
VALDEZ DUCK FLATS SMALL PARCEL PWS 05

We, the undersigned, duly authorized members of the *Exxon Valdez* Oil Spill (EVOS) Trustee Council (Council), after extensive review and after consideration of the views of the public, find as follows:

1. On December 4, 2000, the Council resolved to provide funds for the United States to purchase all of the seller's rights and interests in the small parcel PWS 05, consisting of 32.66 acres, and to provide funds necessary for closing costs recommended by the Executive Director of the Council (Executive Director) and approved by the Council, subject to certain conditions. One of the conditions was that a title search satisfactory to the State of Alaska and the United States must be completed and that the seller is willing and able to convey fee simple title by general warranty deed to the property. The seller is the University of Alaska (University).

2. The Forest Service, on behalf of the United States, has conducted a title search of the property and determined that the University is unwilling to convey fee simple title to the property by general warranty deed. The University was granted the property from the State of Alaska (State), which received the property as part of the State's land entitlement for the University and pursuant to the Alaska Statehood Act. A provision of the Statehood Act, Section 6(i), generally provides that land grants made to the State shall include mineral deposits and that any reconveyance of these lands by the State is subject to a State reservation of all the minerals in the lands conveyed. If lands are conveyed contrary to this provision, the United States may seek appropriate proceedings to forfeit the lands to the United States. When the University received the lands contained in PWS 05 from the State, the mineral estate was included in the grant. The

University has stated that a conveyance of PWS 05 to the United States is subject to Section 6(i) and therefore it is unwilling to convey fee simple title by general warranty deed.

3. For all of the reasons detailed in the Council's resolution of December 4, 2000, the Council continues to find that the purchase of PWS 05 is an appropriate means to restore a portion of the injured resources and services in the spill area.

THEREFORE, we resolve to provide funds for the United States to purchase all of the seller's rights and interests in the small parcel PWS 05 and to provide funds necessary for closing costs recommended by the Executive Director and approved by the Council, pursuant to the following conditions:

(A) the amount of funds to be provided by the Trustee Council to the United States shall be one hundred and twenty five thousand dollars ($125,000) for small parcel PWS 05;

(B) authorization for funding for any acquisition described in the foregoing paragraph shall terminate if a purchase agreement is not executed by September 1, 2002;

(C) completion of a title search satisfactory to the State of Alaska and the United States and the seller is willing and able to convey fee simple title by a deed acceptable to the United States;

(D) no timber harvest, road development or alteration of the land will be initiated by the seller prior to the purchase without the express agreement of the State of Alaska and the United States;

(E) completion of a hazardous materials survey satisfactory to the State of Alaska and the United States;

(F) compliance with the National Environmental Policy Act; and

(G) a conservation easement on parcel PWS 05, satisfactory in form and substance to the United States and the State of Alaska Department of Law, shall be conveyed by the seller to the State of Alaska. It is the intent of the Council that, except as described below, any facilities or other development on the foregoing small parcel shall be of limited impact and in keeping with the goals of restoration and that there shall be no commercial timber harvest nor any other commercial use of the small parcel except such limited commercial use as may be consistent with applicable state or federal law and the goals of restoration to pre-spill conditions of any natural resource injured, lost or destroyed as a result of the EVOS and the services provided by that resource or replacement or substitution for the injured, lost or destroyed resources and affected resources as described in the Memorandum of Agreement and Consent Decree between the United States and the State of Alaska entered August 28, 1991 and the Restoration Plan approved by the Council. The conservation easement will allow for the continued operation and maintenance of the Crooked Creek Visitor Center and fish viewing area by the Forest Service and may provide for the improvement of these facilities consistent with local zoning and the protection of the natural resources and services provided by this parcel.

By unanimous consent, following execution of the purchase agreement between the seller and the United States and written notice from the Executive Director that the terms and conditions set forth herein and the purchase agreement have been satisfied, we request the Alaska Department of Law and the Assistant Attorney General of the Environment and Natural Resources Division of the United States Department of Justice to take such steps as may be necessary for withdrawal of the purchase price for the above-referenced parcel from the appropriate account designated by the Executive Director.

Such amount represents the only amount due under this resolution to the sellers by the United States to be funded from the joint trust funds, and no additional amounts or interest are herein authorized to be paid to the sellers from such joint funds.

Approved by the Council at its meeting of August 6, 2001 held in Anchorage, Alaska, as affirmed by our signatures affixed below:

DAVE GIBBONS
Supervisor, Chugach National Forest
USDA Forest Service

CRAIG TILLERY
Assistant Attorney General
State of Alaska

DAVID B. ALLEN
Alaska Regional Director,
U.S. Fish and Wildlife Service
U.S. Department of the Interior

JAMES BALSIGER
Director, Alaska Region
National Marine Fisheries Service

FRANK RUE
Commissioner
Alaska Department of
Fish and Game

MICHELE BROWN
Commissioner
Alaska Department of
Environmental Conservation