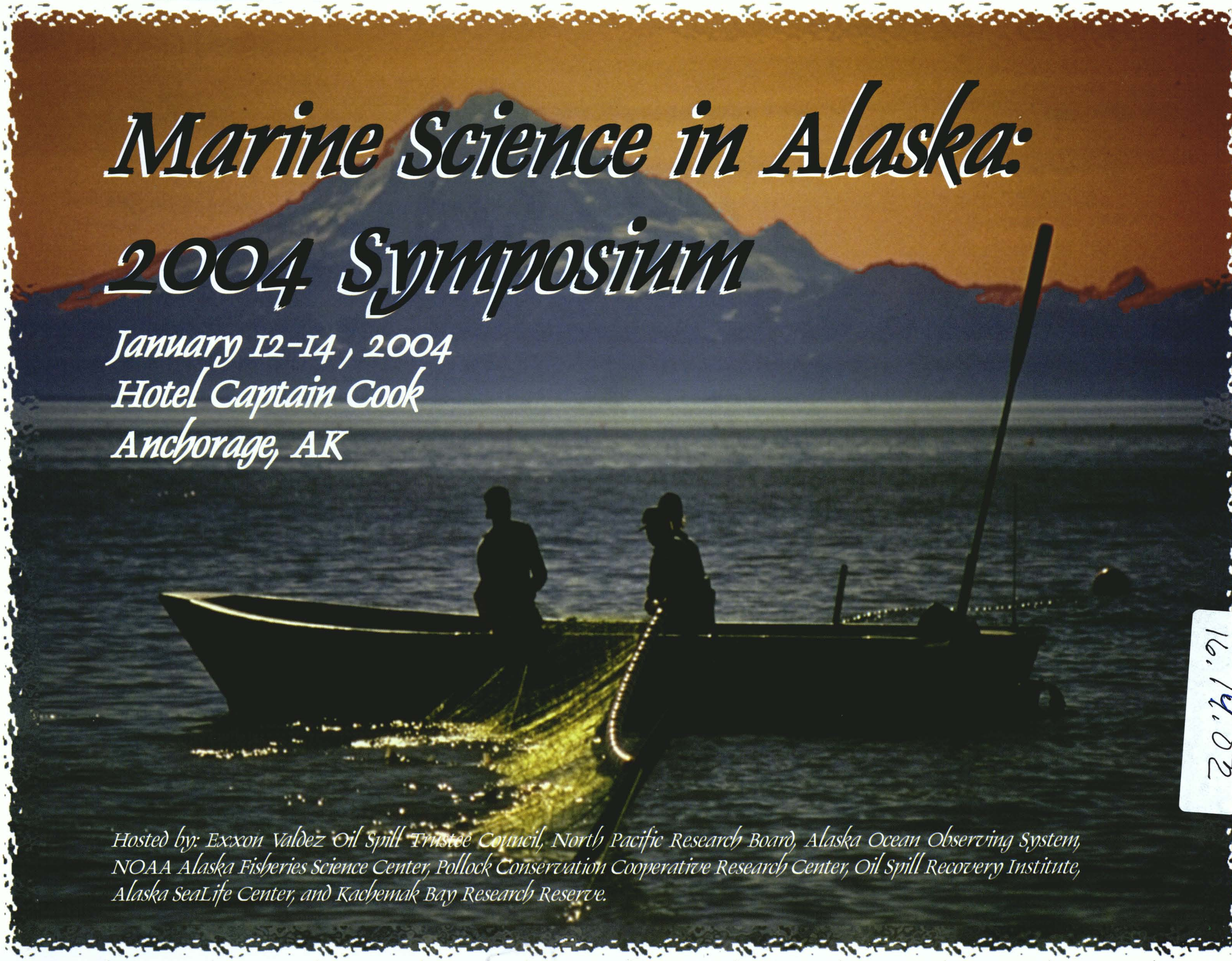

Marine Science in Alaska: 2004 Symposium

January 12-14, 2004
Hotel Captain Cook
Anchorage, AK

Hosted by: Exxon Valdez Oil Spill Trustee Council, North Pacific Research Board, Alaska Ocean Observing System, NOAA Alaska Fisheries Science Center, Pollock Conservation Cooperative Research Center, Oil Spill Recovery Institute, Alaska SeaLife Center, and Kachemak Bay Research Reserve.

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Monday, January 12

1:00 pm – 2:00 pm Convene Symposium - Ball Room (Fore Deck)

1:00 pm – 1:15 pm	Welcome to the Marine Science in Alaska 2004 Symposium – Gail Phillips, *Exxon Valdez* Oil Spill Trustee Council
1:15 pm – 2:00 pm	**Keynote: *EINSTEIN'S ECLIPSE AND MAURY'S LOGS – SEARCHING FOR GENERAL LAWS GOVERNING MARINE ECOSYSTEM PHENOMENA*** **Steven Murawski, National Marine Fisheries Service, Woods Hole, Massachusetts**

2:00 pm – 5:30 pm Program Overviews - Ball Room (Fore Deck)

2:00 pm – 2:15 pm	NOAA Fisheries' Alaska Fisheries Science Center – Richard Marasco
2:15 pm – 2:30 pm	North Pacific Research Board – Clarence Pautzke
2:30 pm – 2:45 pm	*Exxon Valdez* Oil Spill Trustee Council's Gulf of Alaska Ecosystem Monitoring and Research Program (GEM) – Phillip R. Mundy

2:45 pm – 3:15 pm Break - Ball Room (Aft and Mid Deck)

3:15 pm – 3:30 pm	Alaska Ocean Observing System – Molly McCammon
3:30 pm – 3:45 pm	Oil Spill Recovery Institute – G. Carl Schoch
3:45 pm – 4:00 pm	Alaska SeaLife Center Research Program – Shannon Atkinson
4:00 pm – 4:15 pm	Pollock Conservation Cooperative Research Center at the University of Alaska Fairbanks – Vera Alexander and Heather McCarty
4:15 pm – 4:30 pm	NOAA Office of Arctic Research – John Calder

Monday, January 12

4:30 pm – 4:45 pm Kachemak Bay Research Reserve, Alaska Department of Fish and Game – Terry Thompson and W. Scott Pegau

4:45 pm – 5:00 pm Alaska SeaGrant College Program – Brian Allee

5:00 pm – 5:15 pm NOAA's Undersea Research Program – Raymond C. Highsmith

5:15 pm – 5:30 pm University of Alaska's Fishery Industrial Technology Center – Scott Smiley

5:30 pm – 7:30 pm Reception and Poster Session - Ball Room (Aft and Mid Deck)

Tuesday, January 13

Session 1: *CLIMATE CHANGE* Moderator: Mark Johnson, University of Alaska Fairbanks. This session includes talks on the impacts of changing climatic conditions on marine ecosystems and resources. Ball Room (Fore Deck)

8:00 am – 8:25 am ***Recent Shifts in the State of the North Pacific and Bering Sea.***
James E. Overland, NOAA Pacific Marine Environmental Laboratory

8:25 am – 9:00 am ***Summary of Results of a Synthesis Workshop on the Climate Regime Shift Hypothesis of the Steller Sea Lion Decline.***
Arthur J. Miller, University of California San Diego/Scripps

9:00 am – 9:20 am ***Ecosystem Indicators of Climate Change.***
Patricia A. Livingston, NOAA Fisheries' Alaska Fisheries Science Center

9:20 am – 9:40 am ***Environmental Predictors of Walleye Pollock Recruitment in the Eastern Bering Sea.***
Franz J. Mueter, University of Washington

9:40 am – 10:00 am ***A CPR-Based Survey to Monitor the Gulf of Alaska and Detect Ecosystem Change.***
Sonia Batten, Sir Alister Hardy Foundation for Ocean Science

10:00 am – 10:20 am Break - Ball Room (Aft and Mid Deck)

Session 2: *Ocean Observing Systems.* Moderator: Molly McCammon, Alaska Ocean Observing System. This session focuses on local and regional ocean observing efforts as part of the national effort to establish a national observing system. Ball Room (Fore Deck)

10:20 am – 10:40 am **_Study of Environmental Arctic Change (SEARCH) Enhancement of the Arctic Observing System._**
Ignatius Rigor, University of Washington

10:40 am – 11:00 am **_Long-term Measurements on the Bering Sea Shelf: Is the Southeastern Shelf Warming?_**
Phyllis Stabeno, NOAA Pacific Marine Environmental Laboratory

11:00 am – 11:20 am **_Gulf of Alaska Ecosystem Monitoring and Research Program: Monitoring Near-Surface Temperature, Salinity, and Fluorescence in the Northern Pacific Ocean._**
Stephen Okkonen, University of Alaska Fairbanks

11:20 am – 11:40 pm **_Prince William Sound Ocean Observing System._**
Nancy Bird and Walter Cox, Prince William Sound Science Center

11:40 am – 12:00 pm **_Status Report on SEA-COOS: Southeast Atlantic Coastal Ocean Observing System._**
Francisco Werner, University of North Carolina

12:00 pm – 1:00 pm Lunch (provided) - Ball Room (Aft and Mid Deck)

Keynote: _Alliance for Coastal Technology._ Marlin Atkinson, University of Hawaii

Session 3: *Oil Spill Impacts.* Moderator: Robert Spies, Applied Marine Sciences. This session focuses on the current state of knowledge regarding impacts and restoration from the 1989 *Exxon Valdez* oil spill. Ball Room (Fore Deck)

1:00 pm – 1:05 pm **_Introduction: Exxon Valdez Oil in the Nearshore Environment and its Effects._**
Robert Spies, Applied Marine Sciences

1:05 pm – 1:25 pm **_Exxon Valdez Oil in the Nearshore Environment of Prince William Sound – Persistence and Chemistry._**
Jeffrey W. Short, Auke Bay Laboratory, NOAA Fisheries' Alaska Fisheries Science Center

1:25 pm – 1:40 pm **_Recent Exposure of Nearshore Predators to Exxon Valdez Oil._**
Brenda E. Ballachey, U.S. Geological Survey

1:40 pm – 2:00 pm **_Status of Sea Otter Recovery in Western Prince William Sound._**
James L. Bodkin, U.S. Geological Survey

2:00 pm – 2:20 pm **_Process of Harlequin Duck Population Recovery in Oil Contaminated Nearshore Environments._**
Dan Esler, Simon Fraser University

2:20 pm – 2:40 pm Break - Ball Room (Aft and Mid Deck)

Session 4: *Fisheries Oceanography.* Moderator: Bernard A. Megrey, NOAA Fisheries' Alaska Fisheries Science Center. This session ties together species-specific research with physical, chemical and biological oceanography. Ball Room (Fore Deck)

2:40 pm – 3:00 pm **_Predictability of Prey Available to Free-Ranging Steller Sea Lions at Varying Spatial Scales._**
Michael Sigler, Auke Bay Laboratory, NOAA Fisheries' Alaska Fisheries Science Center

3:00 pm – 3:20 pm **_An Examination of the Maturation of Walleye Pollock, Therafra Chalcogramma, in the Eastern Bering Sea in Relation to Temporal and Spatial Factors._**
Jennifer Stahl, University of Alaska Fairbanks

3:20 pm – 3:40 pm **_Jellyfish Impact on Food Web Production and Ecosystem Structure in the Southeastern Bering Sea._**
Alan Springer, University of Alaska Fairbanks

3:40 pm – 4:00 pm **_Shallow Nearshore Fish Assemblages around Steller Sea Lion Haulouts near Kodiak, AK._**
Brenda Konar, University of Alaska Fairbanks

4:00 pm – 4:20 pm **_Reconstructing Sockeye Populations in the Gulf of Alaska Over the Last Several Thousand Years._**
Bruce Finney, University of Alaska Fairbanks

4:20 pm – 4:40 pm **_DNA Analysis of the Origins of Chinook Salmon Bycatch in the Alaska Trawl Fisheries._**
Anthony Gharrett, University of Alaska Fairbanks

4:40 pm – 5:00 pm **_Environmental Cues for Togiak Herring Spawning._**
Naoki Tojo, University of Alaska Fairbanks

5:00 pm – 5:20 pm **_Integration of Marine Bird and Mammal Observations with the Pacific Continuous Plankton Recorder (CPR) Program: Seasonal Variability in Ecosystem Structure._**
William J. Sydeman, PRBO Conservation Science

5:20 pm – 7:00 pm Dinner break (on your own)

SPECIAL SESSION: *KILLER WHALES AND STELLER SEA LIONS.* Moderator: Sue Moore, NOAA Alaska Fisheries Science Center. Ball Room (Fore Deck)

7:00 pm - 7:15 pm **_Kill Rates and Prey Preferences of Southeast Alaska Transient Killer Whales (_Orcinus orca_)._**
Marilyn E. Dahlheim, National Marine Mammal Laboratory, NOAA Alaska Fisheries Science Center

7:15 pm - 7:30 pm **_Feeding Ecology of Transient Killer Whales in the Northern and Eastern Gulf of Alaska._**
Janice Straley, University of Alaska Southeast

7:30 pm - 7:45 pm **_Abundance and Distribution of Killer Whale Ecotypes in Central and Western Alaska (Kenai Fjords to Central Aleutians)._**
John Durban, National Marine Mammal Laboratory, NOAA Fisheries' Alaska Fisheries Science Center

7:45 pm - 8:00 pm **_Whale Killers? Transient Killer Whales in the Eastern Aleutians._**
Craig Matkin, North Gulf Oceanic Society

8:00 pm - 8:15 pm **_The Collapse of Pinniped and Sea Otter Populations in the North Pacific Ocean - An Ecological Legacy of Industrial Whaling?_**
Alan Springer, University of Alaska Fairbanks

8:15 pm - 8:30 pm **_Commercial Whaling and "Whale Killers": A Reanalysis of Evidence for Sequential Megafauna Collapse in the North Pacific._**
Paul Wade, National Marine Mammal Laboratory, NOAA Fisheries' Alaska Fisheries Science Center

8:30 pm - 8:45 pm **_Are Killer Whales the Main Reason for the Decline of the Marine Mammal Population in the North Pacific? A Russian Perspective._**
Alexander Burdin, Visiting Scientist, Alaska SeaLife Center

Session 5: *Species at Risk.* Moderator: Rosa Meehan, U.S. Fish and Wildlife Service. This session focuses on research results related primarily to birds and mammals. Ball Room (Fore Deck)

8:00 am – 8:20 am	***Eider Update.*** Tuula Hollmen, Alaska SeaLife Center
8:20 am – 8:40 am	***Status and Trends of Selected Marine Mammals in Alaska: Steller Sea Lions, Northern Fur Seals, Cook Inlet Beluga Whales, and North Pacific Right Whales.*** J. Ward Testa, National Marine Mammal Laboratory, NOAA Fisheries' Alaska Fisheries Science Center
8:40 am – 9:00 am	***Preliminary Results of At-Sea Capture and Satellite Tracking of Short-Tailed Albatrosses in Alaska.*** Gregory Balogh, U.S. Fish and Wildlife Service
9:00 am – 9:20 am	***Capture and Holding of Transient Juvenile Sea Lions: The Transient Project.*** Jo-Ann Mellish, University of Alaska Fairbanks and Alaska SeaLife Center
9:20 am – 9:40 am	***Sea Otter Populations in Alaska: A Focus on Southwest.*** Angela M. Doroff, U.S. Fish and Wildlife Service

9:40 *am* – 10:00 *am* Break - Ball Room (Aft *and* Mid Deck)

Session 6: *Applied Fisheries Science and Management Issues.* Moderator: Rich Marasco, NOAA Fisheries' Alaska Fisheries Science Center. This session focuses on applying research to address fisheries management issues. Ball Room (Fore Deck).

10:00 am – 10:20 am	***Did Bottom Trawling in Bristol Bay's Red King Crab Brood-Stock Refuge Contribute to the Collapse of Alaska's Most Valuable Fishery?*** C. Braxton Dew, NOAA Fisheries' Alaska Fisheries Science Center
10:20 am – 10:40 am	***Producer Cooperatives and Producer Organizations.*** Gunnar Knapp, University of Alaska Anchorage

10:40 am – 11:00 am ***Monitoring Dynamics of the Alaska Coastal Current and Development of Applications for Management of Cook Inlet Salmon.***
T. Mark Willette, Alaska Department of Fish and Game

11:00 am – 11:20 am ***Disentangling the Relative Roles of Subsistence Harvest and Natural Factors in Altering Rocky Intertidal Food Webs and Ecosystem Productivity on the Kenai Peninsula.***
Anne Salomon, University of Washington

11:20 am – 11:40 am ***The Fishery Interaction Team: Investigating the Potential for Commercial Fishing to Compete with Endangered Steller Sea Lions for Shared Prey.***
Elizabeth A. Logerwell, NOAA Fisheries' Alaska Fisheries Science Center

11:40 am – 12:00 pm ***Application of New Sonar Technology to Reducing Salmon Bycatch in Pollock Trawl Fisheries.***
Craig S. Rose, NOAA Fisheries' Alaska Fisheries Science Center

12:00 pm – 12:20 pm ***Sperm Whale and Longline Fisheries Interactions in the Gulf of Alaska.***
Janice Straley, University of Alaska Southeast

12:20 *am* – 1:30 *pm* LUNCH (Provided) Ball Room (Aft and Mid Deck)
Keynote: *STATUS OF INTERNATIONAL GLOBEC PROGRAM.* Francisco Werner, University of North Carolina, Chair, GLOBEC International Scientific Steering Committee.

Session 7: *UNDERSEA RESEARCH AND OCEAN EXPLORATION.* Moderator: Raymond C. Highsmith, University of Alaska Fairbanks and NOAA's Undersea Research Program. This session focuses on current technological advances that have furthered our knowledge of the ocean, especially ocean habitat. Ball Room (Fore Deck)

1:30 pm – 1:50 pm ***Research on Benthic Habitat at the NOAA Fisheries Auke Bay Laboratory.***
Jonathan Heifetz, Auke Bay Laboratory, NOAA Alaska Fisheries Science Center

1:50 pm – 2:10 pm ***Biologic Exploration of Canada Basin.***
Katrin Iken, University of Alaska Fairbanks

2:10 pm – 2:30 pm ***Effects of Chronic Bottom Trawling on the Size-Structure of Soft-Bottom Benthic Invertebrates in Bristol Bay.***
Robert A. McConnaughey, NOAA Fisheries' Alaska Fisheries Science Center

2:30 pm – 2:50 pm ***Pilot Nearshore Habitat Mapping Using Acoustic and Visual Techniques in Bristol Bay, Alaska.***
John R. Harper, Coastal and Ocean Resources, Inc.

2:50 pm – 3:10 pm Break - Ball Room (Aft and Mid Deck)

Session 8: *Ecosystems Modeling and Data Transfer.* Moderator: Lyn McNutt, University of Alaska Fairbanks, Geophysical Institute. This session highlights the use of models and ecosystem indicators as information products for the public and resource managers and users. Ball Room (Fore Deck)

3:10 pm – 3:30 pm ***Climate Change Effects on Fisheries Recruitment: Comparative Analysis of Statistical Tools to Detect Relationships and Forecast Future Recruitment States.***
Bernard A. Megrey, NOAA Fisheries' Alaska Fisheries Science Center

3:30 pm – 3:50 pm ***Responses of Ichthyoplankton Biodiversity and Dynamics to Environmental Change.***
Wiebke J. Boeing, NOAA Fisheries' Alaska Fisheries Science Center

3:50 pm – 4:10 pm ***Detecting Change in the Bering Sea Ecosystem.***
Sergei Rodionov, NOAA Pacific Marine Environmental Laboratory

4:10 pm – 4:30 pm ***Predicting State-Dependent Foraging and its Ecological Consequences: Harbor Seals Amidst Predators in Prince William Sound.***
Alejandro Frid, Simon Fraser University

4:30 pm – 5:30 pm Concluding Panel providing summation of symposium - Ball Room (Fore Deck)

Marine Science In Alaska: 2004 Symposium
COMMENT AND EVALUATION FORM

Dear Attendee: Your comments are requested on any or all of the following questions.

1. Did you find the symposium valuable overall? Which of the sessions or papers was most valuable or interesting to you?

2. Do you have any suggestions for outstanding keynote speakers for future symposia?

3. How could the poster session be improved? Should we allow posters for topics of marine research, other than just those listed as main sessions for this symposium?

4. Would you like this symposium to be an annual event, or every two years? And was the length of the symposium – 3 days – OK or should it be expanded to allow more sessions?

5. What issues/topics would you like to see addressed at a future symposium?

6. Please provide any additional comments on the symposium that might be helpful in planning future events.

If you are available to be a peer reviewer for Alaska research programs such as GEM, NPRB, and AOOS and are not already on our peer review list, please pick up a form at the registration desk. If you have questions, please contact Rob Bochenek at (907) 278-8012 (EVOSTC). We deeply appreciate your help.

Notes and Contacts:

AOOS
Alaska Ocean Observing System

Exxon Valdez Oil Spill
Trustee Council

NPRB

The symposium sponsors recognize the value of your time and commitment to advancing the marine sciences in Alaska. Your participation in this conference is critical to our mutual success! Plesae accept our sincere gratitude for attending the:

Marine Science in Alaska: 2004 Symposium

Kachemak Bay Research Reserve

UAF University of Alaska Fairbanks
Pollock Conservation Cooperative Research Center

Prince William Sound Oil Spill Recovery Institute

NOAA Alaska Fisheries Science Center
National Marine Fisheries Service

Alaska SeaLife Center
windows to the sea

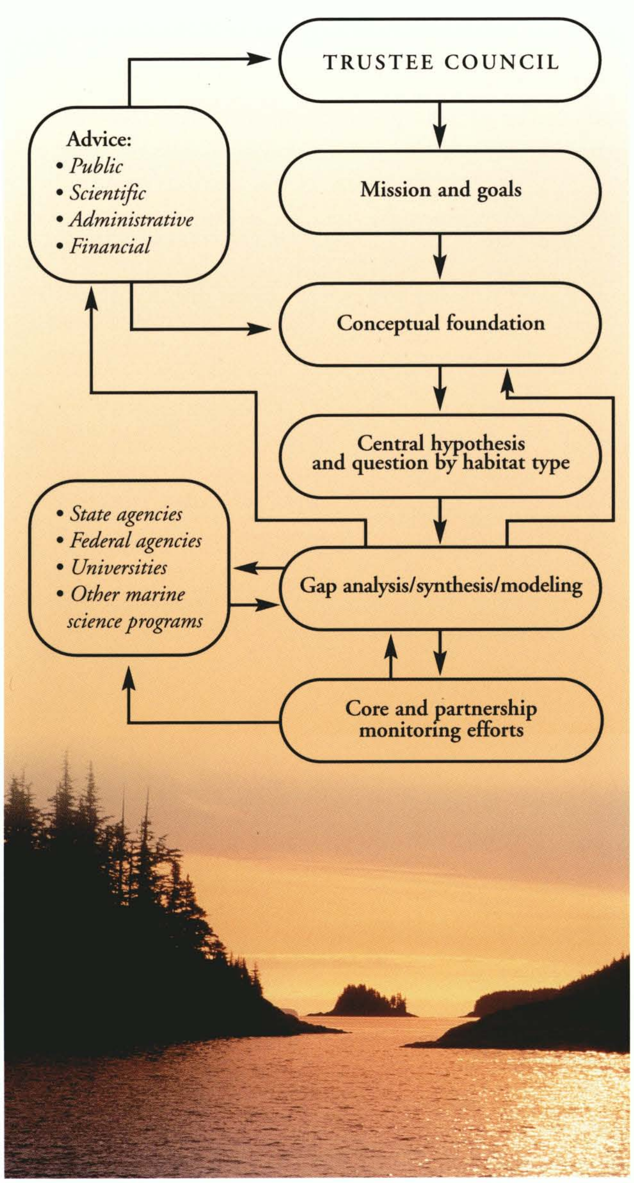
GEM

Gulf of Alaska Ecosystem Monitoring and Research Program

A program of the *Exxon Valdez* Oil Spill Trustee Council • www.oilspill.state.ak.us

HOW WILL GEM WORK? Beginning with the mission and goals developed by the Trustee Council for the GEM program, a working concept about how the Gulf of Alaska ecosystem works is developed. Specific key questions about the working concept, or central hypothesis, will be addressed in each of four habitat types through research and monitoring. The first tool for answering these questions is synthesis, which pulls together existing information on a specific question. Synthesis serves a process called "gap analysis" which involves identifying missing information and locating institutional partners for research, and evaluation and analysis of current scientific knowledge. A database also serves the gap analysis as a tool to identify the projects that are already in place.

HOW GEM COMPONENTS FIT TOGETHER



GEM AT A GLANCE

- The 1989 *Exxon Valdez* oil spill led to a record $900 million settlement to restore the public's natural resources injured by the spill.
- GEM program is the ultimate legacy of the oil spill restoration program.
- GEM is funded with $120 million endowment from the remaining *Exxon Valdez* oil spill settlement funds.
- Annual budget: approximately $5-6 million.

Another important component of the GEM program is the use of computer models, which can:

- represent and examine complex relationships;
- distinguish variability from actual patterns;
- prioritize the most important factors in a system; and
- predict the likely course of future events.

The synthesis, gap analysis and modeling processes will be the primary tasks in the early implementation phase of the GEM program. To prepare for long-term monitoring, short-term research projects will help determine how to answer the most important questions at the lowest cost. Short-term research will also help reveal the core variables, locations and methodology to use in long-term environmental monitoring. Other research will focus on food web dynamics, plankton dynamics, weather, nutrient transport and human impacts.

Monitoring will provide multi-decadal data sets for scientists, resource managers, conservation groups and the public. Given the complexity and size of the Gulf of Alaska, GEM monitoring will include core monitoring done by GEM scientists and partnership monitoring with other organizations A multi-purpose website will provide raw data, maps, diagrams and graphs.

COMMUNITY INVOLVEMENT. Extensive community involvement will be central to the GEM program. Citizen volunteers will assist in observations and data gathering and Alaska Natives will be consulted for traditional ecological knowledge. Strong community involvement will permit the program to compile a more extensive and expansive database.

MISSION

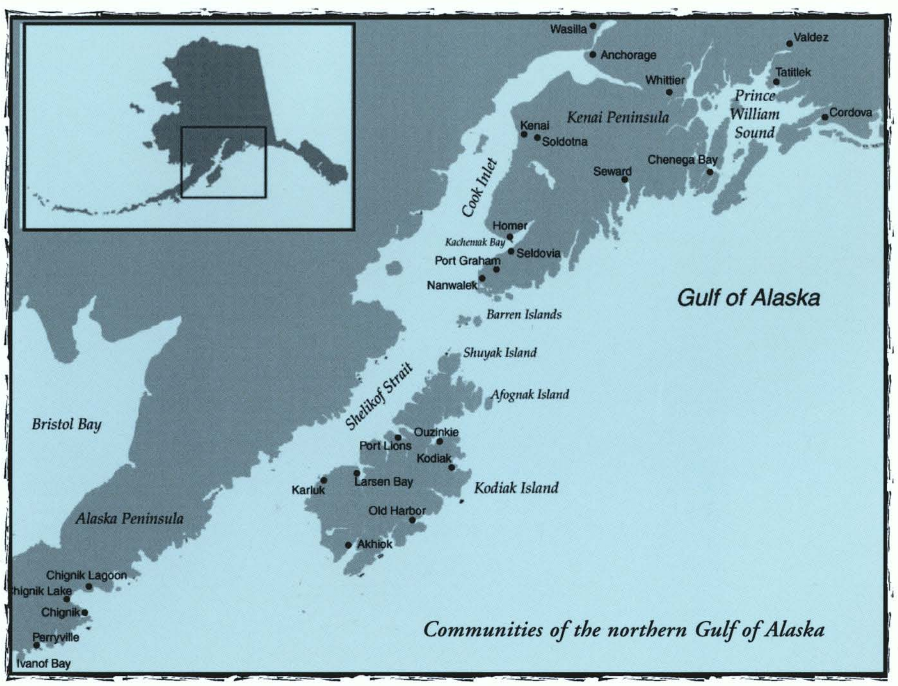
The mission of GEM is to sustain a healthy and biologically diverse marine ecosystem in the northern Gulf of Alaska and the human use of the marine resources in that ecosystem through greater understanding of how its productivity is influenced by natural changes and human activities.

GEM PROGRAM GOALS

- Detect annual and long-term changes in the marine ecosystem
- Understand the causes of these changes
- Inform the public, resource managers, policy-makers and industry about what is happening in the gulf
- Solve problems arising from human activities and help regulators improve resource management
- Predict the status and trends of natural marine resources

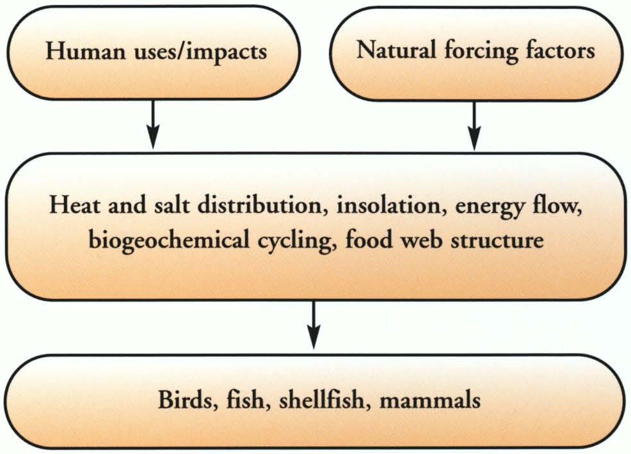
WHAT IS GEM? Imagine a marine research program in one of the world's most productive ecosystems that had indefinite, guaranteed funding. This is the Gulf of Alaska Ecosystem Monitoring and Research (GEM) program, a long-term commitment to gathering information about the physical and biological components that make up a world-renowned marine ecosystem. What makes GEM unique is that it incorporates interagency cooperation and collaboration, public involvement and accessible, informative data and information on the Gulf of Alaska ecosystem. The flagship of the GEM program will be a core monitoring program, which, when combined with the monitoring efforts of other resource agencies and research entities, will help detect environmental change over time and greatly expand understanding of the Gulf of Alaska ecosystems. The program will also include short- and long-term research using the latest technological breakthroughs in marine science. With these, the GEM program will provide a better understanding of the complex processes in the ocean, an understanding that will help us enjoy the great productivity and biodiversity of Alaska's oceans for generations to come.

WHY GEM? The northern Gulf of Alaska is one of the world's most productive ecosystems. Biological production in the gulf provides hundreds of millions of dollars annually in income from the seafood, recreation and tourism industries, as well as the subsistence resources on which many Alaskans depend. The gulf contains 25 species of marine mammals, 26 species of seabirds and 287 known species of fish, and the surrounding area is home to more than half of Alaska's human population. Ultimately, it is our understanding of the Gulf of Alaska and our ability to share information that will determine the future of the gulf ecosystem and the human activities that depend on it. To continue these activities into the future, we must be able to detect environmental change and distinguish between human-caused impacts and natural forces.



Communities of the northern Gulf of Alaska

HABITATS COVERED BY GEM. The GEM program will take place in watersheds, the intertidal and subtidal zones, the Alaska Coastal Current and offshore habitats. These systems are highly interdependent.



Relationships are everything. *The marine ecosystem in the northern Gulf of Alaska depends on the nature of connections between heat and salt distribution, insolation, energy flow, biogeochemical cycling and food web structure. Natural forces and human activities bring about changes in the populations of birds, fish, shellfish and mammals by altering these connections.*

CHANGING POPULATION LEVELS

Some species in the Gulf of Alaska appear to be doing well, while others have declined and still others have almost disappeared:

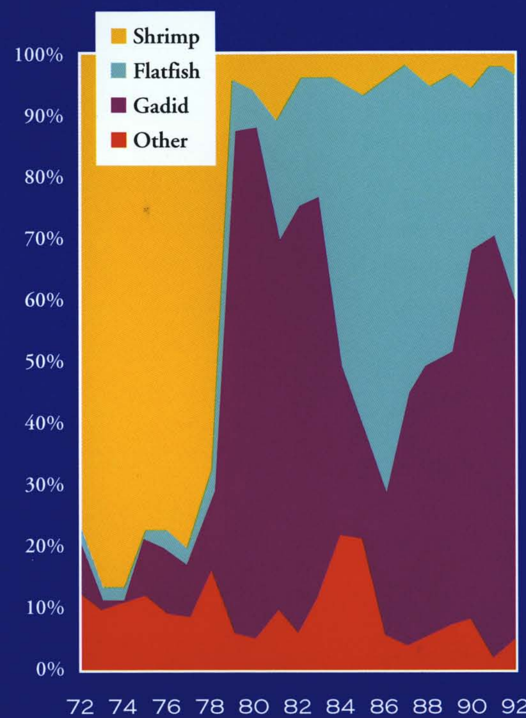
Population declines
- Shrimp
- Red king crab
- Black-legged kittiwakes
- Common and thick-billed murres
- Cormorants
- Sea lions
- Harbor seals
- Fur seals
- Beluga whales
- Common loon
- Some salmon populations

Population increases
- Most salmon populations
- Cod
- Pollock
- Flatfish (arrowtooth flounder)
- Sea otters (not on Aleutians)
- River otters
- Bald eagles
- Sea urchins
- Sharks

WHEN CLIMATE REGIMES SHIFT

Trawl surveys 1970-1976

Trawl surveys 1981-1996



Shrimp populations have decreased dramatically since about 1977-78, while cod and pollock (gadids) and flatfish such as arrowtooth flounder now dominate much of the Gulf of Alaska. The '77-'78 shift mirrors a warming trend within a cycle of cold and warm periods known as the Pacific Decadal Oscillation (PDO). Scientists hypothesize that each cold or warm climate regime favors certain species and harms others. Weather patterns may help explain some biological trends. When weather-related changes can be ruled out, the focus turns to human causes. Scientists now think we may currently be experiencing another regime shift back to cooler ocean conditions, with apparent increases in shrimp and some crab species.

GULF OF ALASKA FACTS

- Steep mountains along the coast of the eastern Gulf of Alaska catch significant rainfall.
- The Gulf of Alaska region is still tectonically active, creating and altering habitats.
- The Aleutian Low Pressure system dominates the Gulf of Alaska climate, influencing storm tracks, air temperature, wind velocities and ocean currents.
- Clouds cover the ocean 60 percent of the time.
- Glaciers cover 20 percent of the gulf watersheds, forming the third largest ice field in the world.

GEM SCIENCE. The GEM approach recognizes that science-based management of marine resources requires an ecosystem-wide approach that takes into account complex processes and dynamic relationships. This can best be accomplished through long-term monitoring and studies repeated over time.

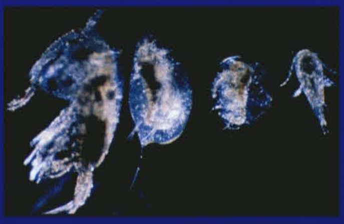
NATURAL CHANGES. It is becoming increasingly clear that climate and oceanography play major roles in controlling biological processes and populations of fish and wildlife important to humans. The set of climatic conditions – also known as the "regime" – at any given time is determined by several processes occurring simultaneously, but on different time scales. Most of these have to do with astrophysical cycles such as variability of the earth's orbit around the sun, the tilt of the earth and the amount of solar radiation entering the atmosphere. They include the El Niño/La Niña Southern Oscillation, the Pacific Decadal Oscillation and global warming, all of which operate on different time scales. The cycle works this way:

1) Large-scale physical processes change the heat content of the atmosphere and ocean, thereby
2) altering currents and climate, which in turn
3) change populations of fish, birds and mammals.
Understanding the relationships among these processes will provide a context for evaluating the potential impacts of human activities.

POTENTIAL IMPACTS OF HUMAN ACTIVITIES. Human activities play a prominent role in the Gulf of Alaska and may have unintended consequences on the overall ecosystem dynamics. Fishing may deplete nutrients and fish stocks, alter sea floor habitat and even affect non-commercial species such as the natural predators of these fish. Tourism may disturb wildlife and add sewage and gray water to marine habitats. Oil spills and chronic leaks occur frequently on a small scale, putting harmful contaminants in the water. Subsistence puts pressure on populations of marine mammals. The pressure may be insignificant when populations are large, but have a substantial effect when populations decline. The goal is not to stop people from these activities, but rather, to help resource managers set reasonable standards that ensure these activities are sustainable.

PHYTOPLANKTON FEED THE SEA

Phytoplankton are the foundation of all life in the sea as we know it. Phytoplankton are microscopic floating plants that convert ocean nutrients and solar energy into a food source that supports the entire ecosystem. As larger organisms eat the plankton, they are in turn eaten by still larger animals such as salmon, seabirds and killer whales.



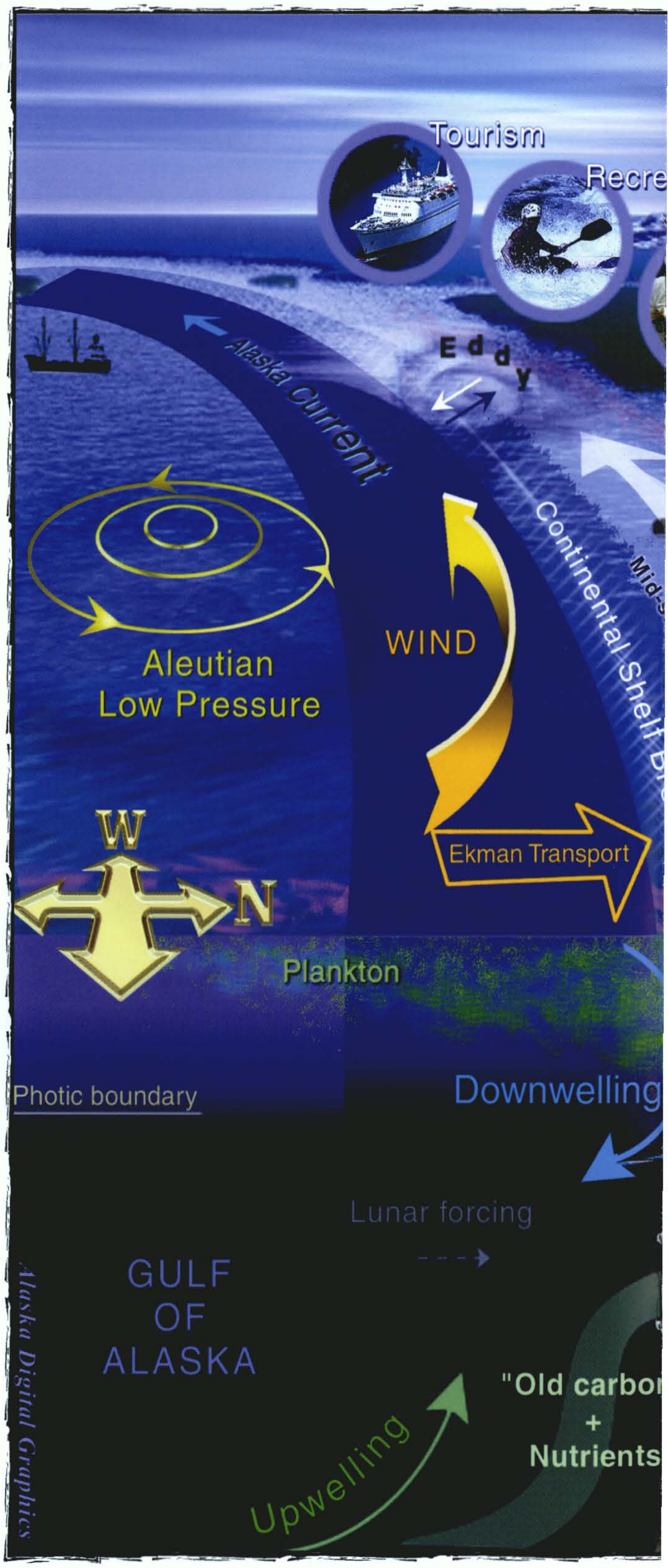
Phytoplankon require a balance of mixing between ocean layers – so nutrients get to the sunlit layers – and stability to keep them in the sunlight. Each spring, the ocean is stratified into layers of different densities and salinities, providing ideal conditions for annual plankton blooms. GEM research will investigate the conditions that cause these blooms and the efficiency with which higher organisms can integrate this explosion of food into the food web.

THE GEM CONCEPTUAL FOUNDATION. *While the northern Gulf of Alaska ecosystem is extremely complex and much remains to be learned, scientists have already compiled an in-depth understanding of the region. The adjacent graphic illustrates the dynamic interface in the Gulf of Alaska between forces on land and at sea. This conceptual foundation serves as a working hypothesis for how the ecosystem works. It will be tested and subsequently updated through GEM monitoring and research projects.*

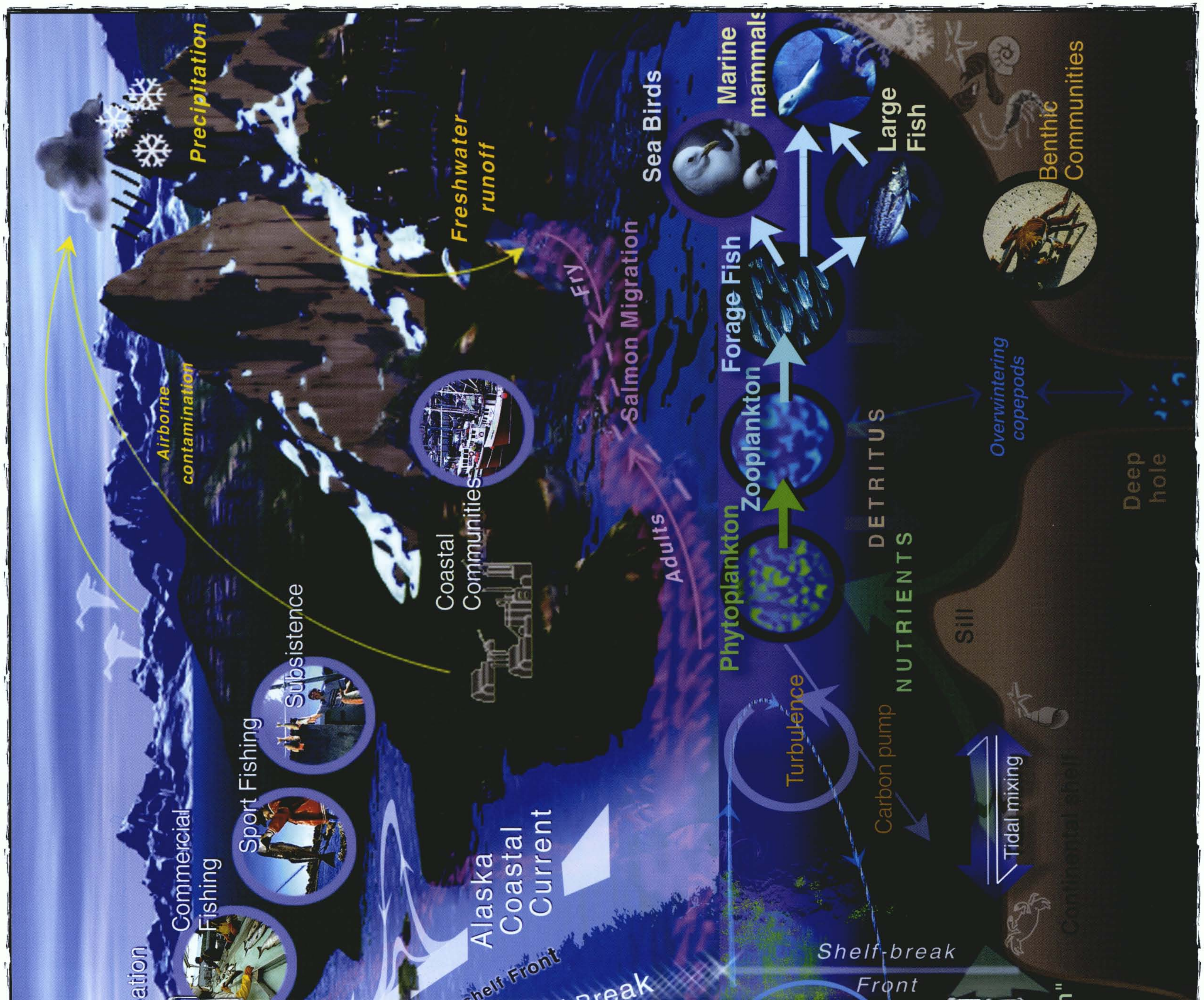
OCEANOGRAPHY AND CLIMATE. *The boundary mountains on land catch precipitation and airborne contaminants from the Aleutian Low Pressure system. Freshwater runoff strengthens the Alaska Coastal Current and carries runoff and contaminants from the watersheds. Meanwhile, weak seasonal upwelling and perhaps lunar forcing bring nutrients and old carbon upwards through the photic boundary where wind-driven mixing and surface currents bring them to where there is enough sunlight for phytoplankton to use the nutrients in photosynthesis. This often occurs where there are underwater structures called "sills" that push currents toward the surface. Winds from the Aleutian Low Pressure system create two counteracting forces. Turbulence keeps nutrients in the photic zone, while shoreward transport causes downwelling, which carries nutrients and plankton out of the photic zone.*

THE FOOD WEB. *Zooplankton link this primary productivity to the production of forage fish, which are the basis for production of larger fish, birds, marine mammals and humans. As surface animals die, they become the detritus that sinks to the ocean floor to feed species in benthic, or bottom-dwelling, communities. Throughout their lifecycle, salmon(shown in pink) link different parts of this ecosystem, migrating as fry from the watersheds all the way to the far offshore region and then back again to spawn as adults.*

HUMAN ACTIVITIES. *Meanwhile, human activities such as tourism, recreation, commercial and sport fishing, and subsistence all depend on these systems and processes occurring in the gulf. At the same time, these activities affect these processes by removing marine organisms, altering coastal habitat, changing animal behavior and depositing waste and contaminants into the marine environment.*



Gulf of Alaska Ecosystem



Nearshore

DESCRIPTION. Intertidal and subtidal areas of the nearshore habitat are brackish and salt-water coastal habitats which extend offshore to 20 meters in depth. These shallow areas are some of the most productive habitats in the Gulf of Alaska and may be the most threatened. These habitats were the most severely affected by the *Exxon Valdez* oil spill and many still harbor oil. In general, these areas have abundant invertebrates such as barnacles, crabs and shellfish and juveniles of many species.

SIGNIFICANCE. Nearshore habitats provide important feeding grounds for larger animals. Terrestrial and aquatic birds, mammals, invertebrates, large fish and even humans depend on food from these rich meeting places of sea and river nutrients. In addition to their importance as feeding grounds, these areas provide nurseries for young marine organisms, unique habitats for specialized animals and are major sources of seaweed production. At the same time, contaminants such as persistent organic pollutants (POPs) may be found in high concentrations in several invertebrate species of the inter- and subtidal zones, providing pathways and potential threats to wildlife and human health. For research purposes, some invertebrate species make excellent biological pollution indicators.

Examples of nearshore monitoring topics:

- Species abundance and composition over time
- How larvae of intertidal animals use currents to disperse throughout the intertidal and subtidal
- Origin and fate of contaminants in shellfish and other invertebrates

MARINE MAMMALS IN THE HABITATS OF THE GULF OF ALASKA

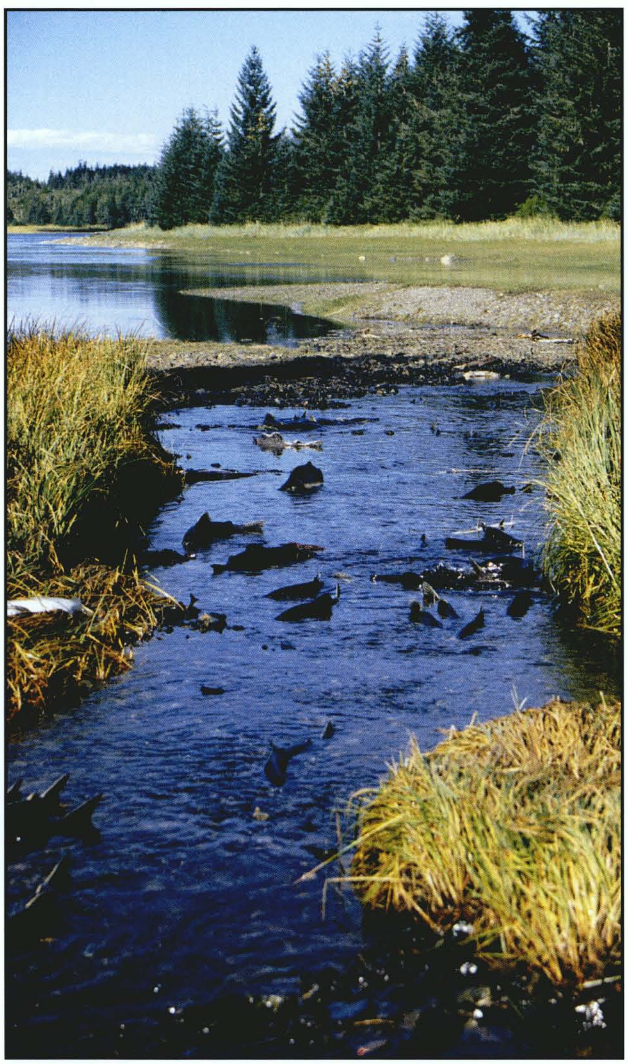
Each species of marine mammal uses the Gulf of Alaska habitats differently. Sea otters and harbor seals are important predators in the intertidal and subtidal habitats, while Steller sea lions occupy the Alaska Coastal Current. Killer whales and Beluga whales move throughout the intertidal, subtidal and offshore regions. Some species of marine mammals are permanent residents of the northern Gulf of Alaska, while others migrate extensively throughout the year. For example, harbor seals, which stay year round, are possibly more affected by climatic and prey changes because they depend solely on this region for their food. Populations may be declining because the current warming regime has changed the abundant prey sources to species that are less nutritious.

Sea otters play a crucial role in maintaining biodiversity in the nearshore habitats. Sea otters prey on sea urchins which, when uncontrolled, sharply reduce nearshore marine plants such as kelp. By keeping the sea urchin populations in check, sea otters control the distribution of many plant and animal species.

Watersheds

DESCRIPTION. Watersheds are freshwater and terrestrial habitats from the mountains to the extent of a river's plume. Links between watersheds and marine areas have been recognized for a long time, but new discoveries are heightening awareness of how strong these links are. The Alaska Coastal Current, for example, is completely dependent on incoming freshwater from rivers, streams and non-point runoff in the gulf.

CONNECTIONS. Watersheds provide rearing habitat for anadromous fish and seabirds such as murrelets and their rivers are pathways for nutrient exchange between terrestrial and marine ecosystems. Woody debris and vegetation from land are also imported to the marine environment, providing a carbon source and habitat for some species. Rivers also deposit iron, sediments and sometimes pollution and contaminants, all of which have varying effects on the sea life downstream. As rocks are worn down by glaciers and weathering, rivers carry minerals and silt to the ocean. Development and clear cut logging can affect watersheds by removing vegetation and increasing soil erosion. Contaminants found in watersheds may be of local origin, and indeed, most contaminated watersheds are located near towns and cities. However, contaminants also are brought by atmospheric processes from as far away as Asia. So far, contaminants from far-away sources have been detected only at very low levels.



Examples of watershed monitoring topics:

- Two-way nutrient and contaminant flow between watersheds and ocean
- Variation in precipitation and stream flow in Gulf of Alaska watersheds
- System-wide effects of physical variables on aquatic and marine organisms

SALMON - A VITAL LINK BETWEEN WATERSHEDS AND OCEANS

After salmon return to watersheds to spawn, their carcasses deposit significant amounts of marine nitrogen into river ecosystems. Nitrogen is a limiting factor for plant growth in many of these systems, so the health of riparian habitats may depend on the salmon returning to spawn. What happens to riparian habitats if salmon numbers change?

Alaska Coastal Current

DESCRIPTION. Just beyond the subtidal zone up to about 30 miles offshore flows the Alaska Coastal Current. This low-salinity channel extends from the mouth of the Columbia River to the end of the Alaska Peninsula. The current is shaped by the tremendous influx of freshwater from the glaciers and thousands of streams flowing into the gulf. Because it is fed in part by ice melt, the current flows at its maximum in late summer and at its minimum in winter. The Alaska Coastal Current is an ever-changing part of the gulf that plays many important ecological roles. For example, it supplies plankton to Prince William Sound and carries fish and invertebrate eggs from one place to another. However, the same coastal flow that benefits so many species may also distribute marine pollutants as seen in the *Exxon Valdez* oil spill. A future toxic spill could be spread across the entire gulf by this current.

SEABIRDS IN THE INTERTIDAL, SUBTIDAL AND ALASKA COASTAL CURRENT

Marbled Murrelet

For several decades scientists have noticed a broad-scale decline in seabird abundance in the gulf, although there are notable exceptions in some localities. Population declines have been noted especially in loons, cormorants, mergansers, puffins, gulls, kittiwakes, terns and auklets. Species such as kittiwakes and murres can be useful indicators of regional marine productivity because their food supply also feeds many other birds, mammals and fish. By assessing the type and quality of food eaten by indicator species, scientists can glean information about the region's overall marine productivity. GEM may contribute to understanding the origins of differences in diet between bird species as well as the effects of variability in prey abundance on seabird breeding biology and population dynamics.

Black-legged Kittiwakes

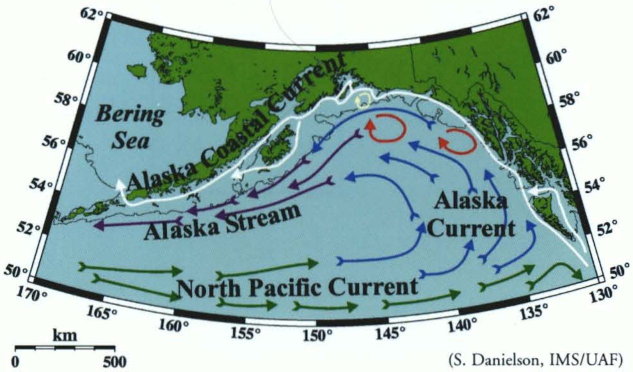
Common Murre

A KEY HABITAT. The success of many species depends on the specific shape of the current, which is influenced by climate, season and sea-floor topography. Juvenile pollock are kept in areas rich in food supply by eddies, circular side currents formed as larger currents move around land masses. Oceanographic features can have a major influence on biological production in the water column, so understanding how they work provides an important piece of the ecological puzzle.

Examples of coastal current monitoring topics:

- Variability of its physical attributes over different time scales
- Effects of climate on current shape and behavior
- Nutrient supply to the photic zone where phytoplankton may uptake them
- Effects of current behavior on productivity
- Effects of current behavior throughout the food web
- Populations and feeding behavior of fish, seabirds and marine mammals

Offshore



As the North Pacific Current moves east toward the coast, much of it becomes the northward-flowing Alaska Current which flows west along the continental shelf break toward the Aleutian Islands.

DESCRIPTION. The offshore region refers to the continental shelf break and the Alaska gyre, a large-scale counterclockwise circulation off the coast. Most large animals of the outer continental shelf and deep sea are fish, the most common being flounder, ocean perch, pollock, halibut and cod. Salmon also use this habitat before they return to the watersheds to spawn. One of the most important processes in this part of the gulf is upwelling, which occurs slowly in the middle of the gyre and at a higher rate in the summer over the shelf break. This upward lift pulls rich deep-sea nutrients to the surface where they can be used by photosynthetic phytoplankton, the primary producers of the marine ecosystem. This process is mediated by climate, especially the Pacific Decadal Oscillation, which can slow down or speed up the wind-driven transport (and perhaps the supply) of deep water nutrients across the shelf to support inshore production. Offshore currents may also carry pollutants originating from as far away as Asia or from deep-ocean dumping and accidents at sea.

Offshore research and monitoring are more difficult due to distance from shore. However, instruments located on ferries, tankers and cruise ships may be useful to obtain offshore data on temperature, salinity, detritus and ocean nutrients. Collected over the long-term, this type of data can put together a big picture of the oceanographic characteristics of the Alaska gyre and the way it changes. A clearer picture of the gyre will permit better understanding of how offshore changes might affect productivity throughout the gulf ecosystem.

Examples of offshore monitoring topics:

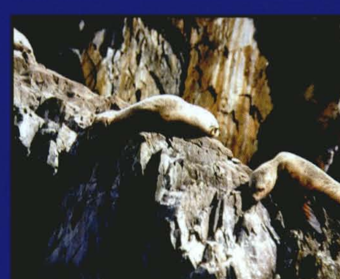
- The effect of climate on nutrients
- How plankton abundance changes over time
- Shoreward flow of carbon produced by plankton
- Variability of the shape and strength of the Alaska gyre
- Variability of offshore temperature, nutrients, salinity and detritus

FOOD WEB INTERMEDIATES

Macrozooplankton such as krill serve as intermediate links in the marine food web between primary producers and higher-level consumers. Forage fish – usually the smaller, less commercially important species – convert the krill into a food source that larger fish, birds and marine mammals can eat. Baleen whales skip this step, feeding directly on the macrozooplankton. GEM is interested in these tiny creatures, barely visible to the naked eye, because their role in the ecosystem is still only vaguely understood.

Macrozooplankton

Forage fish (salmon fry)



Sea lions

Exxon Valdez Oil Spill Trustee Council

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GEM SCHEDULE

- March 1999: Trustee Council decides to endow GEM program.
- 2000: Draft GEM program developed.
- 2000-2002: Intensive review by public, resource agencies, user groups, scientists and the National Research Council.
- Fall 2002: GEM program officially begins, focusing on synthesis of existing data.
- 2003: Pilot monitoring projects begin.
- 2003-2007: Components added until program fully implemented.

ADMINISTRATION

GEM is administered by the staff of the *Exxon Valdez* Oil Spill Trustee Council with funding approved by the Trustee Council. Trustees are:

- U.S. Department of the Interior
- U.S. Department of Agriculture
- National Oceanic and Atmospheric Administration
- Alaska Department of Fish and Game
- Alaska Department of Environmental Conservation
- Alaska Department of Law

GEM is a program of the *Exxon Valdez* Oil Spill Trustee Council
Phone (907) 278-8012 • Fax (907) 276-7178 • www.oilspill.state.ak.us

This Gulf Ecosystem Monitoring Program brochure was released by the *Exxon Valdez* Oil Spill Trustee Council, Alaska Department of Fish and Game, and produced at a cost of $1.42 per copy. It was printed in Anchorage, Alaska.

MARINE SCIENCE in ALASKA

2004 Symposium

Abstracts

JOINT SCIENTIFIC SYMPOSIUM:

Exxon Valdez Oil Spill Trustee Council - Gulf Ecosystem Monitoring

North Pacific Research Board

NOAA Alaska Fisheries Science Center

Alaska Ocean Observing System

Pollock Conservation Cooperative Research Center, University of Alaska Fairbanks

Oil Spill Recovery Institute

Alaska SeaLife Center

Kachemak Bay Research Reserve

January 12-14, 2004 • Hotel Captain Cook • Anchorage, Alaska

Marine Science in Alaska 2004

Joint Scientific Symposium Sessions

<u>Monday, January 12</u>

Afternoon

- PROGRAM OVERVIEWS

Evening

- RECEPTION AND POSTER SESSION

<u>Tuesday January 13</u>

Morning

- CLIMATE CHANGE
- OCEAN OBSERVING SYSTEMS

Afternoon

- OIL SPILL IMPACTS
- FISHERIES OCEANOGRAPHY

Evening

- KILLER WHALES AND STELLER SEA LIONS

<u>Wednesday January 14</u>

Morning

- SPECIES AT RISK
- APPLIED FISHERIES SCIENCE AND MANAGEMENT ISSUES

Afternoon

- UNDERSEA RESEARCH AND OCEAN EXPLORATION
- ECOSYSTEMS MODELING AND DATA TRANSFER

POSTER: Fisheries Oceanography

Maps of Salinity, Nitrate and Chlorophyll over the Gulf of Alaska Continental Shelf

Edward D. Cokelet[1], Calvin W. Mordy[2] and Phyllis J. Stabeno[1]

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The goal of this GLOBEC and GEM research is to relate basic physical and chemical parameters to the ecosystem in the Gulf of Alaska (GoA). We measured sea-surface water temperature, salinity, nitrate, chlorophyll and currents on a NOAA Ship *Miller Freeman* cruise covering the continental shelf from Kodiak Island to Yakutat, 19 July-9 August 2003. Ninety-eight CTD casts provided vertical profiles.

The salinity is higher (32-33 psu) over the basin and lower (20-32 psu) over the continental shelf owing to dilution by freshwater runoff. A brackish portion of the Alaska Coastal Current hugs the coast after leaving Prince William Sound. We produce maps of nitrate in the GoA for the first time. During this summer cruise, higher nitrate (4-11 μM) and higher chlorophyll (1.5-3.5 μg/L), HNHC, predominate in the basin with lower nitrate (0-2 μM) and lower chlorophyll (0-1 μg/L), LNLC, on the shelf. This is because basin nutrients are mixed up from below the pycnocline to replenish the surface and support primary production under summer conditions. However on the shelf, surface nutrients were depleted by the spring bloom and cannot be as easily replenished from deeper waters due to enhanced stratification owing to fresher surface water.

There are important exceptions to HNHC in the basin and LNLC on the shelf. Within a large, 300-km diameter eddy in the basin, measurements show that nitrate and chlorophyll values are lower than in the surrounding basin waters. This is because the anticyclonic eddy contains shelf water that was pulled offshore when the eddy formed near Yakutat. Conversely, there are isolated high-chlorophyll regions on the shelf. These occur around islands and over shallow banks where strong tidal currents mix nutrient-rich water from below, fueling phytoplankton growth. One region corresponds to high nitrate, but another to low nitrate. In the high-nutrient case around the Barren Islands, the vertical flux from mixing apparently kept pace with the bloom. In the low-nutrient case over Portlock Bank, the bloom stripped the nutrients from the slightly stratified surface water.

Program Overviews

<u>Monday 12 January 2004 1:00 – 5:30 PM</u>

Welcome to the Marine Science in Alaska 2004 Symposium
Gail Phillips

Keynote Address: **Einstein's Eclipse and Maury's Logs -- Searching for General Laws Governing Marine Ecosystem Phenomena**
Steve Murawski

NOAA Fisheries Alaska Fisheries Science Center
Richard Marasco

North Pacific Research Board
Clarence Pautzke

***Exxon Valdez* Oil Spill Trustee Council's Gulf of Alaska Ecosystem Monitoring and Research Program (GEM)**
Phillip R. Mundy

Alaska Ocean Observing System
Molly McCammon

Oil Spill Recovery Institute
G. Carl Schoch

Alaska SeaLife Center Research Program
Shannon Atkinson

The Pollock Conservation Cooperative Research Center, University of Alaska
Vera Alexander and Heather McCarty

NOAA Arctic Research Office
John A. Calder

Kachemak Bay Research Reserve, Alaska Department of Fish and Game
Terry Thompson and Scott Pegau

Alaska Sea Grant College Program
Brian Allee

NOAA's Undersea Research Program
Raymond C. Highsmith

The University of Alaska's Fishery Industrial Technology Center
Scott Smiley

Welcome to the Marine Science in Alaska 2004 Symposium

Gail Phillips

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Exxon Valdez Oil Spill Trustee Council
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Opportunities for marine sciences in Alaska have never been better and the importance of the marine sciences to the economic well being of Alaska and to the growth of Alaska's economy has never been greater. The recent Steller Sea Lion Initiative brought more than $100 million to the study of sea lions, fisheries and the ecosystems that support them. The Steller sea lion has come to symbolize the often tight linkages between marine sciences and the Alaskan economy. The Aleutian sea otter or the harbor seal may be the next marine mammal species on which good scientific information will be needed to enable economic activities to proceed in ways that do not put the health of our ecosystems at risk. Opportunities for expanding marine science in Alaska are growing as a result of new federal initiatives from the "Four-Ns" – Navy, NOAA, NASA and NSF. The diverse marine science programs of the state agencies, the universities, and the Four-Ns are now starting to work more closely together and the Symposium is but one example of that cooperation. Programs emphasizing real time monitoring of our nation's coastal environments, such as the Integrated and Sustained Ocean Observing System (IOOS) at the national level are working through programs at the state level, such as the Alaskan Ocean Observing System (AOOS). The *Exxon Valdez* Oil Spill Trustee Council conducted pioneering marine ecosystem-level studies in southcentral Alaska in order to learn how to restore species injured by oiling, and to measure recovery of those species. The Council now looks forward to continuing its work in concert with the many partners represented at the Symposium.

Program Overviews: Keynote Address

Einstein's Eclipse and Maury's Logs -- Searching for General Laws Governing Marine Ecosystem Phenomena

Steve Murawski

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Marine ecosystem research in the 21st century is characterized by unprecedented technical abilities to perform precise measurements, over broad spatial scales, and at increasingly frequent intervals. Data collection capabilities and opportunities have expanded as society's interests in the oceans have fostered a science-based approach to management of ocean resources (as opposed to a negotiation-based approach). Collection, archival and dissemination of physical and biological data products are justified on their own merits for many purposes such as resource inventory, extraction control, and marine safety. However, within these data products, and those we will envision and implement, lie the pieces of many puzzles by which we can hopefully discern process from pattern. Increasingly, society has pressed marine science for better predictive capabilities and integration of constituent parts of systems. This level of understanding can only occur if we can decipher the governing processes and interrelationships that dictate the trajectories we see. Two approaches to developing the underlying laws governing observed phenomena are embodied in the history of science. An empirical test of the Einstein's general theory of relativity was conducted using starlight information collected during a solar eclipse. The opposite approach is embodied in Matthew Fontaine Maury's discerning of circulation patterns in the world's oceans based on mining of countless ship logbook data collected over decades. These two approaches illustrate the duality of theory and data necessary to push many of our investigations from observation to understanding and prediction.

NOAA Fisheries, Alaska Fisheries Science Center

Richard Marasco

Resource Ecology and Fisheries Management Division
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As a result of recent increases in funding for research on Steller sea lions, substantial progress has been made in our understanding of the factors that caused their population to decline since the 1970s and may also threaten their recovery. Six factors have been identified: Predation, Disease, Human-caused direct mortality, Climate Change, Contaminants and Competition with fisheries. Each of these factors has contributed directly or indirectly to sea lion mortalities or can reduce their reproductive success. While the first four factors have been affecting sea lion populations to varying degrees for tens of thousands of years, it is only in the last several decades that the last two factors have been added.

To determine why the sea lion population declined, it is necessary to understand the amplitude and frequency of the long-term factors and place the potential effects of additional factors within this context. Toward that end, the Steller sea lion research program at the AFSC has 5 elements:

- Steller sea lion core studies
- Fisheries interactions
- Forage fish and prey availability
- Biophysical and climate research
- Predation

The AFSC funds studies within each element based on their relevance in addressing one or more of the six factors affecting the sea lion population. In addition, the AFSC coordinates its research with those of our partners in Steller sea lion research in the North Pacific: Alaska Department of Fish and Game, Alaska SeaLife Center, University of Alaska, North Pacific Universities Marine Mammal Research Consortium, Alaska Fisheries Development Foundation, Prince William Sound Science Center and the North Pacific Fisheries Management Council.

One of the main tasks at the AFSC is the assessment of groundfish populations in the eastern Bering Sea, Aleutian Islands and the Gulf of Alaska in support of the scientific management of fisheries. Survey and fishery databases on fish abundance, distribution and age structure, many in excess of 20 years in duration, provide a rich contextual background to the sea lion research studies. Through these combined Steller sea lion and groundfish research efforts, the AFSC is laying the foundation for the incorporation of ecosystem considerations in fisheries management.

North Pacific Research Board

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The North Pacific Research Board (NPRB) was created by Congress in 1997 to recommend marine research activities to the Secretary of Commerce, funded through a competitive grant program using part of the interest earned from the Environmental Improvement and Restoration Fund (EIRF). Its enabling legislation stipulates that EIRF-based funds will be used "...to conduct research activities on or relating to the fisheries or marine ecosystems in the north Pacific Ocean, Bering Sea, and Arctic Ocean (including any lesser related bodies of water)." Further, NPRB must strive "...to avoid duplicating other research activities and shall place a priority on cooperative research efforts designed to address pressing fishery management or marine ecosystem information needs."

The Board's mission is to build a clear understanding of the North Pacific, Bering Sea, and Arctic Ocean ecosystems that enables effective management and sustainable use of marine resources. Toward that end, NPRB supports high quality research projects that will improve the:

- Understanding of the dynamics of the North Pacific marine ecosystem and use of the resources;
- Ability to manage and protect the healthy, sustainable fish and wildlife populations that comprise the ecologically diverse marine ecosystems of the North Pacific, and provide long-term, sustained benefits to local communities and the nation; and
- Ability to forecast and respond to effects of changes, through integration of various research activities, including long-term monitoring.

Since being organized in 2001, NPRB has funded over $8 million in new research supported by EIRF funds in 2002 and 2003, and hopes to fund another $3-5 million in research beginning in 2004. Descriptions of approved projects are available at www.nprb.org. In addition to annual calls for research proposals, the NPRB currently is engaged in a science planning process with the National Research Council which will provide a comprehensive, long-range science plan and associated research priorities in 2005.

Program Overviews

Exxon Valdez Oil Spill Trustee Council's Gulf of Alaska Ecosystem Monitoring and Research Program (GEM)

Phillip R. Mundy

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The mission of the Gulf of Alaska Ecosystem Monitoring and Research (GEM) Program is to sustain a healthy and biologically diverse marine ecosystem in the northern Gulf of Alaska 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. The five general goals of the GEM Program are to 1) 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, 2) Identify causes of change in the marine ecosystem, including natural variation, human influences, and their interaction, 3) 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, 4) 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, and 5) Develop the capacity to predict the status and trends of natural resources for use by resource managers and consumers. The geographic scope of GEM is focused on the area defined by the trajectory of the 1989 oil spill – from the heart of Prince William Sound southwestward to the northern Gulf of Alaska, Kenai Peninsula, Cook Inlet, Kodiak and the upper Alaskan Peninsula. Projects are organized by four key habitat types, Watersheds, Nearshore, Alaska Coastal Current, and the Offshore. Key partners in implementing GEM include most of the partners in AOOS, including the Kachemak Bay Research Reserve (Alaska Department of Fish and Game), Prince William Sound Science Center, University of Alaska School of Fisheries and Ocean Sciences, and National Marine Fisheries Service (NOAA) and National Ocean Service (NOAA). For further information contact the author. The web address for the GEM is **http://www.oilspill.state.ak.us/gem/index.html.**

Alaska Ocean Observing System

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Program Mission and Goals: The Alaska Ocean Observing System (AOOS) is part of a growing national network of integrated ocean observing systems that will improve our ability to rapidly detect changes in marine ecosystems and living resources, and predict future changes and their consequences for the public good. When fully developed, AOOS will serve as the Alaska connection for a national network of observing systems; systematically deliver both real-time information and long-term trends about Alaska's ocean conditions; and be a valuable service for mariners, scientists, industry, resource managers, educators, and other users of marine resources. As currently envisioned, AOOS will facilitate the coordination and integration of regional observing systems in the 1) Arctic Ocean, Beaufort and Chukchi Seas, 2) Bering Sea and Aleutian Islands, and 3) Gulf of Alaska.

AOOS will provide a centralized location for data from new buoys, providing wind and current speed and direction, wave height, sea temperature and salinity, and more; enhancements to existing NOAA weather buoy data for specialized local needs; processed satellite data providing Alaska-wide information on sea-surface temperature, ocean color (chlorophyll) and wind; geographically comprehensive surface current data from high frequency radar; and data about fish, birds and marine mammals, the environmental effects of human activities, and any other information that can be used with the physical data to predict future changes to the ocean ecosystem.

The goals of the national Integrated Ocean Observing System are to 1) improve the safety and efficiency of marine operations; 2) more effectively mitigate the effects of natural hazards; 3) improve predictions of climate change and its effects on coastal populations; 4) improve national security; 5) reduce public health risks; 6) more effectively protect and restore healthy coastal marine ecosystems; and 7) enable the sustained use of marine resources. Alaskans must help prioritize the goals for the Alaska regional system.

Geographic scope: coastal waters of EEZ surrounding state of Alaska.

Key partners: NOAA, University of Alaska, North Pacific Research Board, Alaska SeaLife Center, *Exxon Valdez* Oil Spill Trustee Council, Kachemak Bay Research Reserve, USGS, Minerals Management Service, Arctic Research Commission, Coast Guard, Prince William Sound Science Center/OSRI, Barrow Arctic Science Consortium, State of Alaska, Department of Energy, and other agency, industry, and private sector entities.

Contact information: Alaska Ocean Observing System, 1007 West Third Avenue, Suite 100, Anchorage, AK 99501, Phone: 907-770-6543, Fax: 907-278-6773, mccammon@aoos.org. Website: www.aoos.org

Oil Spill Recovery Institute

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The Oil Spill Recovery Institute (OSRI) is a funding program operating out of the Prince William Sound Science Center in Cordova, Alaska. The mission of this program is to support research, education, and demonstration projects addressing oil spills in Sub-arctic and Arctic oceans. The program was authorized by Congress through the Oil Pollution Act of 1990, but funded projects were not initiated until 1998. Since then, OSRI has awarded an average of $1M per year to support a wide range of projects including: education programs, graduate research fellowships, numerical modeling of atmospheric and oceanic circulation, observational oceanography and meteorology, ecological monitoring of zooplankton, nekton, birds, and marine invertebrates, and developing new oil spill response and recovery technologies. As a leader in piloting and developing designs for larger scale ocean observing systems, OSRI is establishing Prince William Sound as a demonstration site for a node in the Alaska Ocean Observing System. Lessons learned in this relatively protected and accessible corner of the Gulf of Alaska, can potentially be scaled up to other high latitude coasts. OSRI is currently authorized through 2012, and will continue developing the ocean observing infrastructure for PWS, thus providing a rare opportunity for long-term physical and biological monitoring efforts.

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Alaska SeaLife Center Research Program

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From its inception, the Alaska SeaLife Center's main mission was studying the changes in Alaska's marine ecosystems through the development of a world-class research setting designed to attract respected scientists. State-of-the-art laboratories and access to Alaska animals for research projects, particularly those that are listed under the U.S. Endangered Species Act or whose populations are declining, are critical components of the Center's research program. During the first two years of operation, the research department was staffed primarily with visiting scientists. Now the Center's grants fund about 30 staff members. Visiting scientists, however, remain an important part of the Center's research activities. A stable staff has allowed the research department to gain from familiarity with the facility and Alaska resources. A close relationship with the University of Alaska Fairbanks remains an integral part of the Center's research program.

PARTNERSHIPS: Partnerships and collaborations have grown significantly over the past years. The Center continues to work closely with both state and federal agencies who manage Alaska's marine mammals, seabirds and fish to obtain specific permits for research projects. The partnership also includes learning from state and federal biologists and scientists experienced in Alaska's marine wildlife. A significant number of universities also participate in projects, and the involvement has expanded to include a growing international presence, including projects with Japan, Russia, Australia, Canada and Argentina. A special ongoing relationship with Alaska Native organizations, such as the Alaska Native Harbor Seal Commission, helps to integrate customary and traditional science into the Center's research program. Traditional ecosystem knowledge is important in helping to determine changes in the ecosystems and their cause and effect.

FOCUS: The focus of Alaska SeaLife Center research is undergoing changes as the research program matures. Research was primarily oil-related, the result of a significant amount of funding coming from the Exxon Valdez Oil Spill Council (EVOS). Projects completed with EVOS funding have provided a significant amount of knowledge and experience now being applied to other species. Overall, the research program is moving away from single-species study and towards more integrated ecosystem studies.

CURRENT PROJECTS: While research projects involve a wide variety of Alaska's marine mammals, birds and fish, Steller sea lions are a primary research focus. Studies have shown that the decline in western Alaska has been dramatic, as much as 80 percent. Three resident Steller sea lions and three harbor seals are available to support research projects. Staff is developing a permit application to the National Oceanographic and Atmospheric Association (NOAA) to allow for the collection of young Alaskan harbor seals that will support a long-term captive seal energetics, growth and sexual maturity project. One major new research project, the Eider Research Program, began in 2001, but became operational in 2002. The goal of the program is to become increasingly involved with research efforts relevant to the conservation of Steller's and Spectacled Eiders in Alaska. These ducks are listed under the Marine Mammal Protection Act as threatened. The goal is to help reverse the trend of decline so that the birds can be "delisted".

CONTACT: For more information, please go to www.alaskasealife.org.

The Pollock Conservation Cooperative Research Center at the University of Alaska Fairbanks

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The Pollock Conservation Cooperative Research Center (PCCRC) was founded within the School of Fisheries and Ocean Sciences (SFOS) at the University of Alaska Fairbanks in February 2000. The background is as follows: In December 1998, the seven Bering Sea pollock catcher/processor companies formed the Pollock Conservation Cooperative (PCC), a harvesting cooperative designed to rationalize the offshore midwater pollock fishery. Subsequently, PCC signed an agreement with the University of Alaska Fairbanks to form the PCCRC, to address the further goal of supporting marine research in the North Pacific Ocean and the Bering Sea. Funded by annual contributions of $1 million from PCC member companies, the Research Center is administered by SFOS. Proposals to the Center are evaluated for scientific merit through a peer review process, and prioritized by a six-member Advisory Board, which is comprised of two members representing the University, three members representing the PCC, and one representing fisheries management agencies. The Dean of SFOS reviews these recommendations and selects the projects to be funded. The PCCRC Board agrees on research priorities for each funding cycle; for the 2004 awards the priorities are:

- The impact of fishing on the habitat of species of the Bering Sea and Aleutian Islands, and on the ability of that habitat to support diverse natural communities, with a particular emphasis on corals and sponges
- Improvements in fishery stock assessment models
- Improvements in the mitigation, sampling and identification of salmon bycatch in the fisheries
- Pollock stock dynamics, and improved coordination in pollock management in the U.S. and Russia exclusive economic zones
- The sustainability of the northern fur seal and other marine mammals
- Assessment and reduction of interaction between fishing vessels and sea birds in the Bering Sea and Aleutian Islands.

To date, the Center has funded 24 research projects and a seafood technical training program at the University. In addition, a research endowment has been created to support future marine research into perpetuity, and also an endowment fund to establish a chair in oceans policy at the University of Alaska School of Fisheries and Ocean Sciences.

NOAA Arctic Research Office

John A. Calder

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The NOAA Arctic Research Office has recently been realigned within NOAA's overall climate program. Thus the historical focus of the Office on "ecosystems, contaminants and climate" will be replaced with an emphasis on climate issues of Arctic relevance. The US Climate Science Program Strategic Plan will provide overarching guidance. The US interagency Study of Environmental Arctic Change (SEARCH) provides additional scientific guidance. Both of these documents recognize that climate is not just a physical science issue, but that biological and socio-economic issues are also critical. Over the next several years, the Arctic Research Office will focus on studies of Arctic sea ice, Arctic atmospheric observations, and ecosystem response to climate change in the northern Bering and Chukchi Seas and Arctic Ocean. Partnerships with other US agencies, academia and other countries will be essential for conducting this work. This work will focus on achieving defined objectives and outputs, with the long-term goal of specifying and implementing climate-quality observing systems for sea ice, atmosphere and marine ecosystems.

Program Overviews

Kachemak Bay Research Reserve
Alaska Department of Fish and Game

Terry Thompson[1] and Scott Pegau[2]

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The Kachemak Bay National Estuarine Research Reserve, known locally as the Kachemak Bay Research Reserve (KBRR) is the only fjord in the National Estuarine Research Reserve (NERR) system of 26 sites. The reserve system was established across the nation for long-term stewardship, research and education purposes. Designation of KBRR in 1999 was a result of efforts by local citizens who wanted to protect the Bay's qualities and sustain the area's economy, and resource managers who have worked to protect the Bay.

The mission of the Kachemak Bay Research Reserve is to "enhance understanding and appreciation of the Kachemak Bay estuary and adjacent waters to ensure that these ecosystems remain healthy and productive." To achieve this mission the Reserve has identified the following goals:

- Increase understanding of the natural and human processes occurring in the coastal environment.
- Foster responsible stewardship of the coastal environment.
- Foster a public that is involved with and supportive of Reserve activities.

The Reserve's science program is studying the Bay and its surrounding watershed. Areas of emphasis include circulation, primary production, nutrients and wetlands. The education and science programs are integrated – facilitating the transfer of knowledge to people of all ages.

Partnerships are critical to meeting the goals established for the Reserve. Many opportunities exist for partnerships – either those that naturally present themselves and those that are opportunistic. The Reserve currently partners with many different local, regional, state and national entities.

The Reserve's designated boundaries encompass 4,000 km2 (365,000 acres) of terrestrial and marine habitats. The science program region of emphasis will extend to the east as far as the Pye Islands in Kenai Fjords National Park, to the south as far as Shuyak Island in the Kodiak Archipelago, to the west across Cook Inlet, and to the north as far as Kasilof. As a sentinel site for the region, the KBRR will serve a vital function by serving the scientific and management communities with consistent long-term datasets.

Additional information can be found at www.kbayrr.org or call (907) 235-4799.

Alaska Sea Grant College Program

Brian Allee

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The Alaska Sea Grant College Program (ASGCP) has operated in the state for 33 years essentially assisting Alaska in the wise use and conservation of our remarkable marine resources. This has been accomplished through a strategically directed program of research, education, marine advisory services and information transfer to a diverse group of marine constituents in Alaska's coastal communities. As an example of the scope of the program, the ASGCP has helped the seafood industry develop new harvesting and processing methodology, provided food safety training and protocols, trained graduate students through grants directed at greater understanding of our marine ecosystem, produced the Arctic Science Journeys radio series and coordinated the Lowell Wakefield Fisheries Symposium Series. The author will provide more specific details of the diversity of the research portfolio during the oral presentation.

The mission of ASGCP is, as part of the national network of universities, to develop and support research, education, and outreach programs that enhance the wise use and conservation of coastal and marine resources. By assessing the nation's colleges and universities, this federal partnership with the National Oceanographic and Atmospheric Administration (NOAA) increases the "understanding, assessment, development, utilization, and conservation of the nation's ocean and coastal resources by providing assistance to promote a strong education base, responsive research and training activities, and broad and prompt dissemination of knowledge and techniques". The practical reality of developing an effective statewide approach demands a strategic plan, the essential elements of which are: Economic leadership, Coastal Ecosystem Health and Public Safety and Education and Human Resources.

The ASGCP is a partnership with NOAA and all three University of Alaska campuses in addition to state and federal management agencies, local municipalities, numerous non-government organizations, councils and commissions and private and non-profit corporations. The principal contact for the ASGCP is director Brian Allee located at the University of Alaska Fairbanks in the School of Fisheries and Wildlife. The web site address for the ASGCP is http://www.uaf.edu/seagrant/.

NOAA's Undersea Research Program

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The National Oceanic and Atmospheric Administration (NOAA) is responsible for the assessment, protection, development and utilization of U.S. underwater resources. Thus, NOAA established an Undersea Research Program (NURP) consisting of six regional centers and a technology institute for support of *in situ* research and technology development. NURP is a comprehensive underwater research program that places scientists underwater, directly through the use of submersibles, underwater laboratories and advanced wet diving, or indirectly by using remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs) and seafloor observing systems.

The West Coast and Polar Regions Undersea Research Center in the School of Fisheries and Ocean Sciences at UAF serves the U. S. west coast and both polar regions. The Center's mission is to promote, facilitate and support undersea research in Alaska and elsewhere in its region. The Center supports highly rated, peer-reviewed proposals to conduct research utilizing undersea technology. Support provided may be for chartering undersea vehicles, supplies and equipment, travel and salaries for principal investigators, technicians and students. A call for proposals is distributed every May with submissions due in early September. A complete program description and proposal guidelines are available at our website: www.westnurc.uaf.edu.

Center programmatic themes include:

- Fisheries and Fisheries Habitat Research
- Shelf and Slope Ecology
- Ridge Crest Processes
- Marine Tectonics and Plate Boundary Processes
- Seamounts
- Gas Hydrates
- Polar Research
- Cold-Water Diving
- Exploration Research

The Cold-Water Diving program is being developed at our Kasitsna Bay Laboratory on the south shore of Kachemak Bay near Seldovia. We are particularly interested in SCUBA-based research at the Lab as well as elsewhere in Alaska.

Contact information: (907) 474-5870, westnurc@guru.uaf.edu.

The University of Alaska's Fishery Industrial Technology Center

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Alaska Statutes: AS 16.52.010 provided for the establishment of the Fishery Industrial Technology Center (FITC) as part of the University of Alaska. The statutes give guidance on the mission of FITC. Our current mission statement reads. "The Mission of the Fishery Industrial Technology Center is to increase the value of Alaska's Seafood Industry and Marine Resources through research, technological development, education and service."

A significant percentage of Alaskans live within ten miles of the ocean, and the seafood industry is the largest employment sector in Alaska. After petroleum, seafood brings more money to state coffers than any other enterprise. Seafood in Alaska is roughly a $1 billion enterprise annually. In recent years, there have been significant changes in the economics of seafood. Wild salmon has lost much of its value to pen reared fish. A decline in the consumption of surimi-based products has reduced the value of the Alaskan pollock fishery, the largest on Earth. As Alaska progresses into this new century, how will we insure that our coastal communities, whose economic longevity is tied to seafood processing, will remain vital?

A tremendous amount of basic marine research is done in Alaskan waters towards developing an understanding of the dynamics of oceans and of various populations. – be they predator or prey. Yet, if Alaska is not vigilant about keeping our seafood industry productive through cogent applied research, what use will this basic research be to Alaska's coastal communities?

It can take years before the answers to basic research questions find applicability in the seafood industry. We have known that arrowtooth flounder (*Atheresthes stomias*) constitute a biomass of more than 2 million mt since 1995, and yet it is harvested only to a level of about 10% of the ABC. In this talk I review some of the research FITC has done in the past, how we prioritize research, and our focus for the future.

Climate Change

Tuesday 13 January 2004 8:00 – 10:00 AM

Recent Shifts in the State of the North Pacific and Bering Sea
James E. Overland, Sergei Rodionov and Nicholas A. Bond

Summary of Results of a Synthesis Workshop on The Climate Regime Shift Hypothesis of the Steller Sea Lion Decline
Arthur J. Miller and Andrew W. Trites

Ecosystem Indicators of Climate Change
Patricia A. Livingston, Jennifer Boldt and Anne B. Hollowed

Environmental predictors of walleye pollock recruitment in the Eastern Bering Sea
Franz J. Mueter, Michael Palmer and Brenda L. Norcross

A CPR-Based Survey to Monitor the Gulf of Alaska and Detect Ecosystem Change
Sonia Batten and David Welch

POSTERS

Deciphering Change in Climate and the Alaska Coastal Current over the Last 6,000 Years through Stable Isotopic Analyses of Archeological Material
Gail V. Irvine, Scott J. Carpenter, Dan Mann and Jeanne Schaaf

Ocean circulation and freshwater discharge in the Gulf of Alaska
Meibing Jin and Jia Wang

Pelagic Food Webs of Prince William Sound
Thomas C. Kline, Jr.

Changing Patterns of Sea Ice Retreat in the Bering Sea: The Case of the Disappearing Ice Cover
S. Lyn McNutt, James Overland, Phyllis Stabeno, Vera Alexander and Sigrid Salo

Using Gray Whales to Track Climate Change in Arctic Seas
Sue E. Moore and Jacqueline M. Grebmeier

Analysis of the Marginal Ice Zone and the Distribution of *Phoca largha* During Both Cold and Warm Regimes in the Bering Sea
C.M. Picco, S.L. McNutt, V. Alexander, S. Hills, R.R. Gradinger and L.T. Quakenbush

Historical and Regional Aspects of Major Changes in the State of the North Pacific
Sergei Rodionov, James E. Overland and Nicholas A. Bond

A Coupled Ice-Ocean Model in the Pan Arctic and North Atlantic Ocean. Part 1: Simulations of Seasonal Cycles
Jia Wang, Bingyi Wu and Meibing Jin

Search for drivers and causes of climate scenarios: relationship between the Arctic Oscillation/Dipole Forcing and Arctic sea ice
Jia Wang, Bingyi Wu, Meibing Jin, Moto Ikeda and John Walsh

Climate Change

Recent Shifts in the State of the North Pacific and Bering Sea

James E. Overland[1], Sergei Rodionov[2] and Nicholas A. Bond[2]

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The Pacific Decadal Oscillation (PDO) is considered a model of North Pacific climate variability on multi-decadal scales. It is recognized as major atmospheric, oceanographic, and ecological changes near 1976/77. Recent discussion is centered on whether such a shift, with a return to PDO negative conditions, occurred in 1999. The winter mean sea level pressure (SLP) and sea surface temperature (SST) fields for the 4-year period 1999-2002, however, resemble neither the period before nor after the 1976/77 shift. One of the principal characteristics of this recent state is a north-south dipole in SLP with the negative center over the Bering Sea and the positive center over the eastern subtropical North Pacific. This dipole has allowed the northern North Pacific to continue to experience atmospheric forcing characteristic of after the regime shift of 1976/77, while the portion of the North Pacific south of 45°N and east of the dateline has resembled the forcing before the shift. The marine ecosystem of the North Pacific has thus responded with major changes along the west coast of the United States with increased productivity and the return of sub-Arctic species, while oceanographic conditions in the Gulf of Alaska and Sea of Okhotsk have remained in a state associated with an anomalously strong Aleutian low. The PDO model also has regional constraints. For example, the western Aleutian Islands had an almost linear cooling trend and increase in inter-annual and intra-annual variability over the last 40 years. The eastern Bering Sea ecosystem shifted from cold in winter through summer before 1977 to warm in winter after this period, i.e. a PDO influence. However, the 1990s were weakly cold in winter with an early warm spring, reflecting changes in the Arctic airmass. Now the Bering is showing a warm signature from winter through summer.

Summary of Results of a Synthesis Workshop on The Climate Regime Shift Hypothesis of the Steller Sea Lion Decline

Arthur J. Miller[1] and Andrew W. Trites[2]

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The Cooperative Institute for Arctic Research (CIFAR) of the University of Alaska and NOAA's National Ocean Service has funded a group of proposals over the past two years that involve several projects related to the climate regime shift hypothesis of the decline of the Steller sea lion populations in the western Gulf of Alaska and the Aleutian Islands. In order to better understand the combined results of these efforts, CIFAR sponsored a synthesis workshop December 4-5, 2003, in Newport Beach, CA. The objectives were to discuss the implications of the suite of research results and to coordinate the writing of a journal article that synthesizes the results into a coherent picture of what we currently understand.

The participants described many aspects of climate variability over the Northeast Pacific on space and time scales relevant to the decline and discussed the biological response in terms of biogeography and the local sensitivities of various organisms to this physical forcing. The key issues needing to be explained were the temporal decreases in populations observed after the mid-1970s and the spatial west-to-east asymmetry of population changes in the Gulf of Alaska. Physical models were used to better understand the processes involved and to alleviate holes in the observational records. Whole ecosystem studies were discussed that follow the non-linear influence of climate forcing both upwards from the lowest trophic levels and directly at each trophic level, including anthropogenic effects. Paleo-studies provided a long-term perspective to the modern observed changes. Key new results included the recognition of 170W as a change-point from coastal to open-ocean conditions, the identification of the location that the Alaska Coastal Current dies out, and the demonstration that eddy variance distributions changed precipitously in the western Gulf of Alaska after the mid-1970s but remained stable on the eastern side.

The two speakers will present these and other issues discussed at the workshop from the physical oceanographic perspective and the Alaska ecosystem perspective, respectively.

Ecosystem Indicators of Climate Change

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The Ecosystem Considerations section of the Stock Assessment and Fishery Evaluation Reports is provided annually to the North Pacific Fishery Management Council as a means of bringing ecosystem status and change information to the attention of fishery scientists and managers in the hope of building stronger links between ecosystem research and fishery management. The second purpose is to spur new understanding of the connections between ecosystem components by bringing together many diverse research efforts into one document. As we learn more about the role that climate, humans, or both may have on the system, we will be able to derive ecosystem indicators that reflect that new understanding. We report here on the latest climate and biological indicator trends seen in the Gulf of Alaska, Bering Sea and Aleutian Islands based on our 2003 update of this section, which is available on the web at: http://www.afsc.noaa.gov/refm/reem/Default.htm.

Here we report on NOAA's nationwide research program (Ecological Indicators) that is designed to bridge the gap between reports on ecosystem indicators and use of indicators in stock assessments. This program challenges investigators to test the utility of ecological indicators for improving predictions of future production, growth or distribution of fish stocks throughout the North Pacific. This critical analysis step provides stock assessment scientists and policy makers a quantitative measure of the level of uncertainty associated with predictions of future stock status. The indicators presented from both of these efforts include large-scale atmospheric indices, regional physical oceanographic variables, species-specific trends, biological community indicators, and ecosystem-level analyses. These indicators were contributed by numerous individuals from the Alaskan and NOAA research community; representing multiple federal, state, and university efforts to understand the effects of climate on ecosystem production.

Environmental predictors of walleye pollock recruitment in the Eastern Bering Sea

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We developed a series of statistical models linking walleye pollock recruitment in the Eastern Bering Sea to climatic and oceanographic conditions at regional and larger spatial scales. Specifically, we modelled relationships between the recruitment or survival of larval and juvenile walleye pollock (ages 0-2), stock size, and relevant environmental variables using linear and non-linear models. Predictor variables were carefully selected based on four general hypotheses that have been advanced to explain variations in pollock recruitment. The cold-pool hypothesis of Wyllie-Echeverria and Wooster (1998) relates survival of larval and/or juvenile pollock to the severity of winter ice conditions and to the size and temperature of the resulting pool of cold bottom water on the shelf. Two prey availability hypotheses, incorporating aspects of the recently proposed oscillating control hypothesis of Hunt et al. (2002), related pollock survival to the presence or absence of an ice-related spring bloom and to summer stratification and temperatures on the middle shelf region. Finally, we examined the advection/predation hypothesis of Wespestad et al. (2000), which relates pollock recruitment to the degree of separation between juvenile and cannibalistic adults. The degree of separation, in turn, is believed to be related to the passive drift of larvae into favourable or unfavourable areas.

To examine the evidence for and against each of the proposed hypotheses we obtained relevant predictor variables based on the literature or from available data sets and constructed a limited set of statistical models of recruitment. These models will be used to assess the performance of each predictor variable and to assess the strength of evidence for a given hypothesis. The best models for each hypothesis will be combined into one or several models for predicting walleye pollock recruitment in the Eastern Bering Sea. The performance of the final predictive model(s) will be evaluated in a retrospective analysis and their use in stock assessment will be discussed.

A CPR-Based Survey to Monitor the Gulf of Alaska and Detect Ecosystem Change

Sonia Batten[1] and David Welch[2]

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The Continuous Plankton Recorder has been deployed from Volunteer Observing Ships in the north Pacific to sample plankton on a routine basis beginning in 2000. These data, together with the results of the pilot program in 1997, are now sufficient to provide a measure of large-scale inter-annual variability in plankton quantity and community composition. Significant differences are apparent between the warm year of 1997 and the more recent cooler conditions holding since the regime shift of 1998/99. The recent high returns of salmon to the Columbia and Fraser Rivers coincides with the switch to plankton communities that are more favorable to salmon. During the 2003 field season of a subset of the collected samples were processed very rapidly (within a few weeks of collection), the data were compared to the existing database to provide an assessment of the current plankton community, and then summary results were posted on the project web site. As part of our presentation we will review the time series of plankton information and the conditions measured in 2003.

Deciphering Change in Climate and the Alaska Coastal Current over the Last 6,000 Years through Stable Isotopic Analyses of Archeological Material

Gail V. Irvine[1], Scott J. Carpenter[2], Dan Mann[3] and Jeanne Schaaf[4]

[1]US Geological Survey, Alaska Science Center
[2]University of Iowa
[3]University of Alaska, Fairbanks
[4]National Park Service, Anchorage

Changes in marine ecosystems occur on multiple scales of space and time. Historical records of atmospheric and ocean temperature changes indicate fluctuations of multiple periodicities; these may be linked to changes in the abundance of species or composition of marine assemblages. High resolution, retrospective climate and biotic data that span millennia are rare. We report on paleoceanographic/paleoclimatic data from our natural stable isotope ($\delta^{18}O$ and $\delta^{13}C$) analyses of bivalve midden material from Mink Island (XMK-030), located in the Shelikof Strait of the Gulf of Alaska. These data provide insight into how climate and biological productivity of the Alaska Coastal Current (ACC) have changed over the last ~6,000 years.

Bivalve material from middens was selected for analysis based on its representation of well-documented climatic episodes. Results of the stable isotope analysis of ancient bivalve midden material contrasted with comparable analyses of modern material from the same site have revealed marked differences in ocean conditions through time. These differences are reflected in variation in both $\delta^{13}C$ and $\delta^{18}O$ isotope ratios from shell carbonates sampled at high resolution across individual shells of the butter clam, *Saxidomus giganteus*, and mussel, *Mytilus trossulus*. This high-resolution sampling provides sub-monthly data, and individual shells can provide data that cover multiple years. Modern material shows a relatively close association of ocean temperature/salinity, as indicated by $\delta^{18}O$, and productivity, as suggested by the $\delta^{13}C$ values. This close association of isotopic patterns is not as sustained in ancient shells. Preliminary data from ancient shells indicate that climate change has had a profound impact on freshwater influx to the ACC and that productivity has varied markedly over the last 6,000 years. Especially striking are contrasts in the seasonal patterns and strengths of productivity and temperature/salinity indicated by Little Ice Age (~ 540 years before present [BP]) and Mid-Holocene Thermal Optimum (~5750 BP) shell material. Data from Medieval Warm Period material show different and somewhat more mixed patterns than the other two climate periods. The data from these different climate periods may help predict how climate parameters and ocean productivity may change in the future.

POSTER: Climate Change

Ocean circulation and freshwater discharge in the Gulf of Alaska

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A high-resolution 3-D ocean circulation model of the Gulf of Alaska (GOA) and a Digital Elevation Model (DEM) hydrological model were introduced. The model area covers the entire GOA, including PWS and Cook Inlet. The horizontal resolution of this model is 4'x2' minutes (about 3.7km at 60N). The most updated results of the circulation model and hydrological model were presented. Modeled transport of Alaska Stream compares well with observation at 180W. Regional model showed a relatively stable Alaska Stream and unstable Alaska Current with high ratio of eddy/mean energy.

POSTER: Climate Change

Pelagic Food Webs of Prince William Sound

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Food webs are intrinsically important for understanding changes in marine populations. Two food web parameters of importance are food chain length and source of production. Because approximately an order of magnitude is lost, in terms of matter or energy, with each feeding interaction, food chain length can determine productivity of higher trophic levels. High trophic level organisms, by definition, are those dependent upon long food chains. If food chain length increased, less energy and matter would be available to higher trophic levels. Conversely, if food chain length decreased, more energy and matter would be available. Productivity originating in the Gulf of Alaska can subsidize higher trophic levels in coastal bodies of water such as Prince William Sound. Gulf zooplankton production fluctuates on inter-decadal times scales. The available Gulf subsidy should fluctuate accordingly.

The natural abundance of nitrogen and carbon stable isotope ratios measured at the organism level reflected relative trophic level and production source, respectively. Stable isotope analysis was performed on pelagic organisms of Prince William Sound during the mid-1990's, a period of time when the second principal component of the north Pacific winter sea-surface temperature, a climatic indicator, was consistently negative. During this time the nitrogen stable isotope ratio (NSI) trophic level baseline indicator was consistent. Trophic levels based upon NSI were consistent with those produced by a mass-balance model. During the mid-1990s, 50% or more of Prince William Sound fish production was subsidized by Gulf production based upon carbon stable isotope ratio (CSI). The maximum Gulf subsidy occurred during 1995, when about nine-tenths of the carbon in Pacific herring and walleye pollock juveniles came from the Gulf. This analysis can serve as a base for future comparisons when climatic indicators are different. Future NSI and CSI analyses can be used to test for shifts in trophic level and subsidy, respectively, using this baseline.

Changing Patterns of Sea Ice Retreat in the Bering Sea: The Case of the Disappearing Ice Cover

S. Lyn McNutt[1], James Overland[2], Phyllis Stabeno[2], Vera Alexander[3] and Sigrid Salo[2]

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In the Bering Sea, there is an important relationship between sea ice retreat the health of the ecosystem in general. Changes to the location, extent and condition of the sea ice during meltback, notably in the transition period from spring into summer, play an important role in heat and salt flux on the shelf, introducing cold (-1.7° C), fresh water, critical to density stabilization and primary productivity on the shelf. Until recently, studies of climate variability for the North Pacific and Bering Sea have focused on the winter season. While climate changes may not be as large in spring as winter, they can be observed in the sea ice record. Changes to the spring meltback patterns will impact the upper ocean and its biota. One of the key changes that affect the Bering Sea and Alaska is a shift toward warmer temperatures in spring. This has resulted in one week earlier ice melt in the Bering Sea in the 1990s relative to the 1980s and a two-week earlier snow melt at Barrow in the late 1990s. In essence, there is an earlier transition from winter to summer.

The changes to the ice retreat in the Bering Sea are most evident in the monthly averaged ice conditions for May. In this study we use sea ice records from the National Ice Center and the Special Sensor Microwave Imager (SSM/I) for 1972-2003. We find that there have been five distinct patterns of ice retreat for the Bering Sea, which sort themselves roughly into the following categories: south to north; east and west; west to east; east to west and extreme melt. Each provides evidence of changing patterns related to different atmospheric conditions: warm; cold; cool; and very warm. We will use a combination of modeled data and remote sensing information to describe how the meltback in the Bering Sea has changed from the 1970s to the present. This information will provide baseline data for investigating observed biophysical changes on the Bering Sea shelf, especially in the Northern Bering Sea near St. Lawrence Island and the Bering Strait.

POSTER: Climate Change

Using Gray Whales to Track Climate Change in Arctic Seas

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Climate warming has resulted in extreme seasonal retreats and thinning of sea ice in the western Arctic. However, other less obvious effects of warming on Arctic marine communities are difficult to discern. Because marine mammals are apex predators in the short food chains common to the Arctic, they can be good indicators of ecosystem response to climate change. Gray whales, due to their benthic foraging capability, may provide a clear link between atmospheric forcing and the pelagic-benthic coupling processes required to support a dense prey base. To explore this link, a 5-day aerial survey was conducted over the Chirikov Basin in the northern Bering Sea during summer 2002. In the 1980s, the Chirikov Basin was a prime gray whale feeding area, with an extremely productive benthic prey community. However, no comprehensive assessments of whale or prey distribution and abundance have occurred since then.

The 2002 survey for gray whales revealed restricted distribution in the basin and a 3 to17-fold decline in sighting rates compared to the 1980s. Many more whales were seen north of Bering Strait, where sighting rate was 0.49 whales/km compared to only 0.03whales/km in the basin. Available measurements of biomass suggest a downturn in prey abundance that began as early as 1983, when estimates of gray whale population size were still increasing. These data, and reports of hundreds of gray whales feeding in the south-central and northwest Chukchi Sea and southeast of Kodiak Island in the Gulf of Alaska, suggest that benthic communities in the Chirikov Basin may no longer support large aggregations of whales and that gray whales are foraging elsewhere. Since multi-decade time series data are available for the Chirikov Basin, long-term studies of this area are encouraged to investigate predator-prey responses to changing ocean climate.

POSTER: Climate Change

Analysis of the Marginal Ice Zone and the Distribution of *Phoca largha* During Both Cold and Warm Regimes in the Bering Sea

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In the Bering Sea, physical processes associated with the continental shelf form a productive upwelling system known as the "Green Belt". In years of colder temperature regimes, when the sea ice reaches the continental shelf, this upwelling enhances the high productivity of the marginal ice zone (MIZ). In warmer temperature regimes this productivity enhancement is decoupled, affecting the amount of available nutrients for the ice edge community. Consequences from changes in primary productivity are intensified with increasing trophic levels. Fish populations concerned such as Arctic cod (*Boreogadus saida*) and walleye pollock (*Theragra chalcogramma*) are important prey and/or competitors of the pagophilic spotted seal (*Phoca largha).* Spotted seals use pack-ice on the marginal ice zone of the Bering Sea as a platform to feed, give birth, nurse their young and mate.

We hypothesize that recent changes in the extent and productivity dynamics of the MIZ has had strong effects on the distribution and community structure of the spotted seal, among others, migration patterns, nutritional status, and reproductive success. A retrieval of archival data will endeavor to determine how changes in ice substrate and prey dynamics of the Bering Sea have affected the distribution of the spotted seal. A comprehensive analysis to determine the location and status of the MIZ in the Bering Sea using SAR (Synthetic Aperture Radar) and AVHRR (Advanced Very High Resolution Radiometer) satellite sensor data from both cold (early 1970's) and warm (1990's) regimes will be plotted with archived spotted seal distribution data collected by the Alaska Department of Fish and Game (ADFG).

POSTER: Climate Change

Historical and Regional Aspects of Major Changes in the State of the North Pacific

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The Pacific Decadal Oscillation (PDO) is often considered as a model of North Pacific climate variability on multidecadal scales. It is well recognized that there were major atmospheric, oceanographic, and ecological changes near 1976/77, with a shift from the "negative" to the "positive" phase of the PDO. Recent discussion is often centered on whether such a shift, with a return to PDO negative conditions, occurred in 1999. The winter mean sea level pressure (SLP) and sea surface temperature (SST) fields for the 4-year period 1999–2002 as a whole resemble neither the period before nor after the 1976/77 regime shift. Our interpretation is that climate variations other than those strictly associated with the PDO characterize the recent state of the North Pacific. One of the principal characteristics of this state is the north-south dipole in SLP with the negative center over the Bering Sea and the positive center over the eastern subtropical North Pacific. This dipole has allowed the Gulf of Alaska and Bering Sea to continue to experience atmospheric forcing characteristic of that after the regime shift of 1976/77, while the portion of the North Pacific south of 40°N and east of the dateline has resembled the forcing before the regime shift. Moreover, the PDO appears to have limited relevance to the climate variability of the Aleutian Islands. The eastern Aleutian Islands, for example, demonstrate an abrupt shift to warmer conditions in the late 1970s. In contrast, the western Aleutian Islands did not experience such a shift. Instead, surface air temperature (SAT) variations in this region feature a cooling trend over the last four decades. These east-west differences in temporal SAT patterns may have implications for sea lion populations. Examining an ecosystem response to climate variations requires a comprehensive analysis of information pertinent to both basin-wide and regional forcing mechanisms.

A Coupled Ice-Ocean Model in the Pan Arctic and North Atlantic Ocean: Part 1: Simulations of Seasonal Cycles

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A coupled ice-ocean model (CIOM) is configured for the pan Arctic and North Atlantic Ocean (PANAO) with a 27.5 km resolution. The model is driven by the daily atmospheric climatology averaged from the 40-year NCEP reanalysis (1958-1997). The ocean model is the Princeton Ocean Model (POM), while the sea ice model is based on a full thermo-dynamical and dynamical model with plastic-viscous rheology. A sea ice model with multiple categories of sea ice thickness is utilized. We first focus on seasonal cycles of sea ice and ocean circulation. This model reasonably reproduces seasonal cycles of both the sea ice and the ocean. Climatological sea ice areas derived from historical data are used to validate the ice model performance. The simulated sea ice cover reaches a maximum of 14×10^6 km^2 in winter and a minimum of 6.7×10^6 km^2 in summer, which are close to the 95-year climatology with a maximum of 13.3×10^6 km^2 in winter and a minimum of 7×10^6 km^2 in summer. The simulated general circulation in the Arctic Ocean, the GIN seas, and northern North Atlantic Ocean are qualitatively consistent with historical mapping. We found that the winter low salinity or freshwater content in the Canada Basin tends to converge due to the strong anticyclonic atmospheric circulation that drives the anticyclonic ocean surface current, while summer low salinity or freshwater tends to spread inside the Arctic and exports out of the Arctic, due to the relaxing wind field. It is also found that the warm, saline Atlantic Water intrudes farther into the Arctic in winter than summer due to prevailing winter wind stress over the northern North Atlantic that is controlled by the Icelandic Low. Seasonal cycles of temperature and salinity at several selected representative locations reveals regional features that characterize different water mass properties.

POSTER: Climate Change

Search for drivers and causes of climate scenarios: relationship between the Arctic Oscillation/Dipole Forcing and Arctic sea ice

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Using a coupled ice-ocean model developed by Wang et al. (2002), we investigate the responses of the Arctic Ocean climate (or ice-ocean system) to the Arctic Oscillation (AO) and the second mode (or so-called dipole forcing, DF). Seven high AO index winters and six low AO index winters (similarly, the high and low DF index winters) were simulated by the coupled ice-ocean model under forcing provided by the NCEP/NCAR reanalysis. Statistical analyses and tests were applied to the composite differences between the high and low AO indices. For the high AO index phase that predominated during the 1990s, the results showed a reduction of sea ice in the Arctic Basin accompanied by an increase of sea ice in the Labrador Sea. This pattern resembles the North Atlantic Oscillation seesaw pattern (Roger and van Loon 1979; Wang et al. 1994). During the high AO phase, the Arctic surface salinity increases and the surface temperature decreases, implying that more new ice was produced. The enhanced ice production is a consequence of greater ice export from the Arctic Ocean in response to anomalous cyclonic wind stress. From the subsurface layer to the Atlantic water layer, there is also a seesaw pattern in ocean temperature between the Barents and the Labrador Seas. During the high AO phase, the model reproduces the anomalous temperature intrusion of the Atlantic Water. While both the anomalous surface wind stress and the thermodynamical forcing contribute to sea ice and ocean variability, statistical analyses (EOF, regression, etc.) and significance tests (T-test and F-test) show that the wind stress accounts for a greater portion of these changes during the high AO phase than the thermodynamical forcing. We found that sea ice export is closely related to the DF, rather than the AO.

Ocean Observing Systems

Tuesday 13 January 2004 10:20 AM – 12:00 PM

Study of Environmental Arctic Change (SEARCH) Enhancement of the Arctic Observing System
James Morrison and Ignatius Rigor

Long-term Measurements on the Bering Sea shelf: Is the southeastern shelf warming?
Phyllis Stabeno, Jeff Napp, J. E. Overland and Terry Whitledge

Gulf of Alaska Ecosystem Monitoring and Research Program: Monitoring near-surface temperature, salinity, and fluorescence in the Northern Pacific Ocean
Stephen Okkonen

Prince William Sound Ocean Observing System
Nancy Bird and Walter Cox

Status report on SEA-COOS: SouthEast Atlantic Coastal Ocean Observing System
Francisco Werner and Harvey Seim

POSTERS

Aerial Observations of Zooplankton using LIDAR
James H. Churnside and Richard E. Thorne

A Numerical Hydrological Model for Freshwater Discharge into the Gulf of Alaska
Jia Wang, Meibing Jin, Dave Musgrave and Moto Ikeda

Study of Environmental Arctic Change (SEARCH) Enhancement of the Arctic Observing System

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The Study of Environmental Arctic Change (SEARCH) has been conceived as a broad, interdisciplinary, multiscale program of long-term observations (including paleo and historical), analysis, and modeling with a core aim of understanding the complex of significant, interrelated, pan-Arctic changes that have occurred in recent decades (Unaami). This complex of changes is affecting every part of the Arctic environment and is having repercussions on society.

The SEARCH Strategy includes a detailed list of activities required to address the SEARCH goals. The activities are grouped into eight activity areas:

- Arctic System Reanalysis (ASR) will assimilate data into models of various components of the Arctic system to produce optimum estimates of key variables.
- Detecting and Quantifying Unaami (DQU) and Related Modes of Variability will use paleoclimate, historical, and archeological records as well as more recent observations to better define the scope of Unaami and its relation to other decadal modes of variability.
- Social and Economic Interactions (SEI) will examine the interactions of the physical and biological elements of Unaami with social and economic systems.
- Large-scale Atmospheric Observatories (LAO) will make large-scale atmospheric observations and includes the use of several large land-based stations around the Arctic.
- Distributed Marine Observatories (DMO) will make large-scale atmospheric (surface), oceanographic, sea ice and ecosystem observations in the marine environment.
- Distributed Terrestrial Observatories (DTO) will make large-scale atmospheric (surface), hydrological, glaciological, and ecosystem observations in the terrestrial environment.
- Linkages and Global Coupling (LGC) will use modeling and analysis to elucidate the connections between Unaami and global climate and the connections within the Arctic system as they pertain to Unaami.
- Social Response (SOR) will research social and economic adaptation to climate change in the past and apply research on Unaami to economic and social concerns in the future.

Generally, the SEARCH activities should include many existing activities and enhance these to provide our descendents with the understanding and long-term records they will need to deal with a changing environment. The SEARCH web page can be found at:http://psc.apl.washington.edu/search/index.html.

Ocean Observing Systems

Long-term Measurements on the Bering Sea shelf: Is the southeastern shelf warming?

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Biophysical measurements have been made at mooring Site 2 (56.88°N, 164.03°) almost continuously since 1995, providing the longest near continuous time-series of biophysical variables on the Bering Sea shelf. A series of moorings have also been deployed at Site 4 (57.85°N, 168.87°W) since 1995, providing almost five years of more sporadic data. Added to data collected by the moorings, water property measurements have been made along the 70-m transect since 1995. Such long-term observations provide critical data that allow characterizations of interannual variability, quantification of regime shifts and climate change.

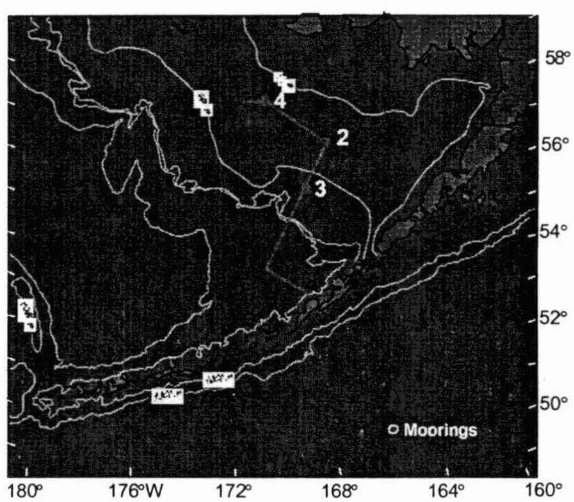

Figure 1. Bathymetry of the southeastern Bering Sea. The location of Sites 2 and 4 and the monitoring line occupied during BS FOCI and SEBSCC. A mooring is no longer maintained at Site 3, but hydrographic and plankton samples are still taken at this location when adequate funding is available.

Temperature records from Site 2 reveal a large seasonal cycle. The well-mixed water column is of January persists until buoyancy is introduced to the water column either through ice melt or solar heating. The water column exhibits a well-defined two-layer structure throughout the summer consisting of a 15-25 m wind mixed layer and a 35-40 m tidally mixed bottom layer. Deepening of the mixed layer by strong winds and heat loss begins as early as mid August, and by early November the water column is again well mixed.

During any given year marked variations are superimposed on annual cycle. For instance, the lack of ice over the southeastern shelf during recent winters resulted in significantly higher ocean heat content during summer. A marked warming during winter in ocean temperatures has occurred during the last three years (2002 was cooler than the other two years, but still warmer than in 1995-1999). Surface air-temperature has shown similar warming patterns. The mid to late 1990s were characterized by earlier spring transitions resulting in above average spring and summer air temperatures. During the last three years, in addition to positive surface air temperature anomalies during the spring and summer, winter anomalies are also positive.

These warmer conditions can trigger changes in the Bering Sea ecosystem. A possible indicator of such a change was the occurrence of coccolithophore blooms over the Bering Sea shelf during the summers of 1997-2001, and its reappearance this September. Another possible indicator is the northward migration of the population of snow crab, Chionoecetes opilio from 58° to 60° N (>200km).

Gulf of Alaska Ecosystem Monitoring and Research Program: Monitoring near-surface temperature, salinity, and fluorescence in the Northern Pacific Ocean

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Near-surface temperature and salinity fields in the northern Gulf of Alaska exhibit well-defined seasonal cycles. Lowest temperatures are observed in the late winter and the highest temperatures are observed in mid-autumn. The lowest salinities are observed in mid-autumn and the highest salinities are observed in late winter and early spring. Large-scale temperature and salinity differences between the shelf break and northern Prince William Sound are roughly 3°C and 4 psu, respectively. Prominent fronts occur near the shelf break and Hinchinbrook Entrance. A weaker front is sometimes observed in northern Prince William Sound outside of Valdez Arm.

Prince William Sound Ocean Observing System

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The Prince William Sound Ocean Observing System (PWSOOS) is a long-term program of the Prince William Sound Science Center to deliver key information on physical and biological conditions to a wide variety of end users. The system combines near real-time and conventional ocean and meteorological observations to provide measured conditions, with a suite of numerical models to provide atmospheric and oceanographic forecasts. This information includes raw data on environmental conditions, such as wind speed, air temperature, precipitation, ocean currents, ocean temperature, tide height, and water salinity as well as modeled forecasts of anticipated conditions. Ongoing efforts seek to combine biological observations of important fisheries stocks (such as herring population dynamics in PWS) with the physical modeling program. The ultimate goal of these efforts is to improve our ability to predict natural changes.

PWSOOS builds upon a science foundation developed through the Sound Ecosystem Assessment research program (funded by the Exxon Valdez Oil Spill Trustee Council) in the mid 1990's and the Prince William Sound Nowcast-Forecast program (funded by the Oil Spill Recovery Institute) begun in 1998. These programs both targeted similar goals: developing an ecosystem level understanding of the Prince William Sound region through integrated physical and biological research efforts.

At its most basic level PWSOOS consists of three primary elements, data collection activities (such as weather monitoring for gathering atmospheric data, ocean observing for collecting oceanographic data, and acoustic monitoring for the collection of biological data), data modeling (simulations of past, present and future ocean and atmospheric conditions with plans underway to model key biological information), and an information dissemination component (delivery of information to end-users via the Internet – www.pwsoos.org - and other means).

Status report on SEA-COOS: SouthEast Atlantic Coastal Ocean Observing System

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The SouthEast Atlantic Coastal Ocean Observing System (SEA-COOS, www.seacoos.org) is a regional partnership that has initiated an integrated coastal ocean observing system for a four-state (North Carolina, South Carolina, Georgia and Florida) region of the southeast coastal U.S. The long-term intent of SEA-COOS is to establish a regional coastal ocean observing system that will be part of the coastal component of the national Integrated Ocean Observing System (IOOS) envisioned by Ocean.US. SEA-COOS was initiated in September 2002 with funding from the Office of Naval Research (ONR) as a coordinating and enhancing effort between several existing subregional-scale efforts in the southeast, the Sea Grant Offices from the four states, and a number of federal agencies. The essential elements of an observing system, the region-wide observations, overlapping circulation models, data management capabilities, governance, and outreach and education activities of SEA-COOS, at present and planned for the coming year will be briefly described.

POSTER: Ocean Observing Systems

Aerial Observations of Zooplankton using LIDAR

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An aerial survey of Prince William Sound was performed on 14 May 2002 using the NOAA Fish LIDAR. The flight was made just after a surface survey on 10-12 Maythat measured zooplankton concentrations in the Sound using acoustics and sampling. Sampling revealed that *Neocalanus* was the primary constituent of zooplankton in the Sound. The concentrations were measured in 8 areas of the Sound using a 420 kHz echosounder as the primary instrument. Lower frequencies were also used to correct for the return from fish in the beam. The largest concentrations of zooplankton were observed in the eastern part of the Sound, including the main basin and the Hinchenbrook Entrance. Using a technique common in acoustics, we applied a threshold to the LIDAR data to remove the return from low-level scatterers. Since the LIDAR target strength of plankton has yet to be measured directly, we varied the threshold level and compared the results with the acoustic results in the 8 areas. The best agreement was found with a threshold level of 2.75, relative to the background scattering level. With this threshold, the correlation between the LIDAR and echosounder results was 0.78.

POSTER: Ocean Observing Systems

A Numerical Hydrological Model for Freshwater Discharge into the Gulf of Alaska

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Freshwater discharge into the Gulf of Alaska (GOA) has an important effect on the coastal circulation. In order to incorporate freshwater discharge into a 3-D ocean circulation model with both point source (from big rivers) and line source (from gridded coastline), a digital elevation model (DEM) was developed to calculate freshwater discharge into GOA under forcing of daily air temperature and precipitation data from NCEP/NCAR reanalysis during 1958-98. This GOA-DEM includes glacier and snow storage and melting processes. Coastal freshwater discharge into GOA displays a very strong seasonal cycle and interannual variation. The comparison of simulated runoff with gauged (observed) river runoff was conducted for two major rivers (Copper River and Susitna River), showing a good agreement on seasonal cycle and interannual variability. The simulated annual mean of the total freshwater discharge into GOA ranges from 19,000 to 31,000 m^3s^{-1} (with a mean of 23,100 m^3s^{-1}) for the period of 1958-98, consistent with the previous estimates (23,000 m^3s^{-1}) by Royer (1982). In the winter season (November to April), precipitation is mainly stored as snow, and freshwater discharge remains as a small base flow with some occasional changes by short time temperature rise. Freshwater discharge starts to rise sharply from May due to increasing precipitation and rising temperature over freezing point, and remains high from June through September because of snow melting from lower to higher altitude and some melting glaciers. In October, the discharge decreases rapidly to a basic flow as the temperature drops below freezing point.

Freshwater discharge into GOA can be divided into the point source (big rivers) and the line sources (ungauged numerous small streams and creeks due to melting of snow and glaciers). The model shows that five major rivers (point source) account for about 50.6% of the total drainage areas, while the line source accounts for 49.4% of the drainage area. However, our new finding is that the point (line) source accounts for 26% (74%) of the total discharge runoff. Thus, discharge from line sources (ungauged small rivers, streams, and creeks) is 2.8 times greater than the point source (five large rivers). This model makes it possible to investigate the effect of freshwater discharge on the coastal current with realistic freshwater input at each grid point (i.e., the line source) into a 3-D circulation model of GOA.

Oil Spill Impacts

Tuesday 13 January 2004 1:00 – 2:20 PM

***Exxon Valdez* Oil in the Nearshore Environment of Prince William Sound: Persistence and Chemistry**
Jeffrey W. Short

Recent Exposure of Nearshore Predators to *Exxon Valdez* Oil
B.E. Ballachey[1], J. L. Bodkin[1], D. Esler[2] and P.W. Snyder[3]

The Status of Sea Otter Recovery in Western Prince William Sound
J. L. Bodkin[1], B.E. Ballachey[1], and P.W. Snyder[2]

The Process of Harlequin Duck Population Recovery in Oil Contaminated Nearshore Environments
Dan Esler

POSTERS

Cytochrome P4501A Induction in Oil-Exposed Pink Salmon Embryos Predicts Reduced Survival Potential
MG Carls, RA Heintz, GD Marty and SD Rice

Recovery of pink salmon spawning habitat after the *Exxon Valdez* oil spill
MG Carls, SD Rice, GD Marty and DK Naydan

The role of copepods in the distribution of hydrocarbons
Switgard Duesterloh, Thomas C. Shirley, Jeffrey W. Short and Mace G. Barron

Trophic dynamics of intertidal mudflats: Copper River Delta
Sean P. Powers, Mary Anne Bishop and Charles H. Peterson

Exxon Valdez Oil in the Nearshore Environment of Prince William Sound: Persistence And Chemistry

Jeffrey W. Short

Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA

We estimated the amount of oil remaining in Prince William Sound, Alaska, 12 years after the 1989 *Exxon Valdez* spill to assess its importance as a long-term reservoir of toxic hydrocarbons. We found oil on 77 of 91 beaches randomly selected according to their oiling history. Surface oiling was recorded for randomly placed quadrats, which were then excavated and examined for subsurface oil. The cumulative area of beach contaminated by surface or subsurface oil was estimated at 11.3 ha. Surface oil varied little with tide height, but subsurface oil was more prevalent at the lower tide heights. This unexpected distribution of subsurface oil with respect to tide height is probably a result of interactions between beach porosity, oil viscosity and capillary forces. The mass of remaining subsurface oil is conservatively estimated at 55,600 kg. Analysis of terpanes indicated over 90% of the surface oil and all of the subsurface oil was from the *Exxon Valdez*, and that Monterey Formation oil deposited after the 1964 Alaska earthquake accounted for the remaining surface oil. These results indicate that oil from the *Exxon Valdez* remains by far the largest reservoir of biologically available polycyclic aromatic hydrocarbons on beaches impacted by the spill, and that biota dependent on these beaches risk continued exposure.

Oil Spill Impacts

Recent Exposure of Nearshore Predators to *Exxon Valdez* Oil

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Through 2003, oil from the 1989 *Exxon Valdez* spill still could be found along shorelines of western Prince William Sound. Some nearshore vertebrate predator species, including sea otters and harlequin ducks, remain below prespill abundance, and exposure to residual oil is thought to be a factor constraining recovery of these species. To assess bioavailability of residual oil, we have used the cytochrome P450 1A (CYP1A) biomarker which, if elevated, is a specific indicator of exposure to aromatic hydrocarbons. In previous studies (1995-99), CYP1A was measured in a suite of vertebrate predators that inhabit nearshore areas: river otters, sea otters, pigeon guillemots, harlequin ducks, Barrow's goldeneyes and masked greenlings. All six species showed evidence of oil exposure, with species that consume invertebrate prey, including sea otters and harlequin ducks, apparently at greatest risk. We have continued to monitor CYP1A levels in harlequin ducks (sampled in 2000-2002) and sea otters (sampled in 2001-2003), comparing individuals in oiled and unoiled areas. During this period, CYP1A levels in harlequin ducks in oiled and unoiled areas have converged, indicating abatement of oil exposure for this species. For sea otters, results through 2002 show elevated CYP1A levels persisting in the oiled area, but there is some suggestion that exposure has decreased over time. Our data indicate that nearshore vertebrates were exposed to residual *Exxon Valdez* oil far longer than anticipated, that population recovery was constrained by chronic exposure to residual oil, and that we may be seeing reductions in exposure after 14 years, suggesting that direct effects of oil may be diminishing. However, full recovery of some populations may not occur until exposure to residual oil is completely over; the time scale required for that to occur is uncertain.

The Status of Sea Otter Recovery in Western Prince William Sound

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Data accumulating through at least 2001 document the persistence of unexpected volumes of *Exxon Valdez* oil in the intertidal sediments of Prince William Sound (PWS) shorelines most severely affected by the spill. The sea otter (*Enhydra lutris*) is a nearshore marine mammal that spends significant amounts of time excavating sediments in the shallow subtidal zone to retrieve clams, a preferred invertebrate prey that sequesters environmental hydrocarbons. Results of population surveys demonstrate that while recovery of sea otter populations may be evident at the scale of PWS, within those areas where shorelines were most heavily oiled, recovery remains incomplete. Data on prey availability, body condition and activity budgets do not implicate food as a factor limiting recovery. From 1996-2002, sea otters at heavily oiled northern Knight Island had significantly higher CYP1A levels than otters from unoiled Montague Island, and in 2001-2003, sea otters at Knight were found to have a relatively high incidence of liver abnormalities. However, during the period of study, we have seen a decline in the CYP1A measures from the oiled area, and prior differences in serum enzymes indicative of liver damage have diminished. Based on models incorporating sea otter foraging behavior, prey selection, and sea otter abundance, we propose that by foraging in intertidal sediments, sea otters may be responsible for the liberation of residual oil and therefore are effectively restoring oiled habitat. However, they may be suffering prolonged injury from chronic exposure to lingering oil encountered during foraging activities. Further, variation in individual foraging strategies likely results in markedly variable exposure to oil, accounting for the highly skewed distribution of CYP1A values measured among individuals at Knight Island.

The Process of Harlequin Duck Population Recovery in Oil Contaminated Nearshore Environments

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The 1989 *Exxon Valdez* oil spill resulted in contamination of the nearshore environment of Prince William Sound, an important wintering area for harlequin ducks. The effects of the spill on wildlife populations varied by species, but the harlequin duck was one for which long-term, population-level effects were documented. These effects included reduced overwinter survival of females in oiled areas, as well as strong evidence of continued exposure to oil, based on induction of cytochrome P4501A (CYP1A). No evidence of recovery was detected through 1998. During winters 2000-03, we followed up on these studies, collecting the same data endpoints. By 2003, we found that female survival and CYP1A induction were similar between oiled and unoiled areas, suggesting that spill related injury was no longer occurring. This series of studies, along with parallel studies of sea otters, is an unprecedented documentation of the recovery process and timeline for oil spill injured wildlife. The time necessary for injury to abate was more than a decade, much longer than the conventional assumption that oil spill effects are negligible after a year or two. In addition, detailed work on harlequin duck dispersal in Prince William Sound revealed extremely high site fidelity and documented that harlequin duck aggregations are demographically isolated at small geographic scales (10s of kilometers). This suggests that recovery to pre-spill numbers, even in the absence of continued direct effects of the spill, may take decades.

POSTER: Oil Spill Impacts

Cytochrome P4501A Induction in Oil-Exposed Pink Salmon Embryos Predicts Reduced Survival Potential

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Cytochrome P4501A (CYP1A) induction in pink salmon (*Oncorhynchus gorbuscha*) embryos exposed to crude oil is causally linked to adverse effects at cellular, organismal, and population levels in pink salmon and can be used to predict these responses. When combined with the results of this experiment, designed to examine CYP1A induction during embryonic stages and growth after emergence, results from a series of experiments spanning four other brood years demonstrate that CYP1A induction is related to a variety of lethal and sublethal effects, including poorer marine survival, reduced growth, poorer predator avoidance, and abnormalities. The lowest observed effective total polynuclear aromatic hydrocarbon (TPAH) concentration in water causing significant physiological responses, including reduced size, was the same as that causing CYP1A induction ($< 0.94\ \mu g/L$). Thus, CYP1A induction is not only a biomarker, it can be considered a bioindicator; induction in early life stages implies long-term negative consequences for the individual and the population.

Recovery of pink salmon spawning habitat after the *Exxon Valdez* oil spill

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Intertidal sediment surrounding many pink salmon (*Oncorhynchus gorbuscha*) spawning streams in western Prince William Sound was contaminated by the *Exxon Valdez* oil spill. Biochemical and egg-dig evidence suggested that oil reduced the survival of pink salmon embryos for several years. Previous research also demonstrated that dissolved oil can be transferred to developing embryos from surrounding oiled sediment via drainage of interstitial water as a result of tidal cycling and hydraulic gradients. In this study, completed a decade after the spill, we sampled stream water for the presence of oil using passive membrane sampling devices, collected sediment and pink salmon eggs for hydrocarbon analysis, and examined alevins for induction of cytochrome P4501A (CYP1A). Polynuclear aromatic hydrocarbons (PAH) consistent with *Exxon Valdez* oil were verified in the water of one of six heavily impacted streams; total PAH concentrations were greatest in the lower intertidal. Similarly distributed total PAH in a second stream suggested possible contamination. Oil was not detected in the remaining four streams. Induction of CYP1A in alevins from the two streams with oil was lowest in water above mean high tide and increased downslope. Because our samples were all selected from heavily oiled streams, we infer that most pink salmon spawning habitat either has recovered or is recovering.

POSTER: Oil Spill Impacts

The role of copepods in the distribution of hydrocarbons

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Copepods may provide a significant pathway for the concentration and transfer of polyaromatic compounds (PAC) to higher trophic level consumers. PAC dissolved from weathered crude oil are more persistent in the environment and have much higher toxicity than the lighter, more volatile fractions of crude oil. Because of their polarity they tend to accumulate in bio-lipids. Subarctic copepod species can contain up to 80% of their body dry weight in lipids and have a high surface area to volume ratio. Thus, PAC accumulation is rapid and bioaccumulation factors are in the order of 500-8000, depending upon species and lipid content.

While direct, toxic effects of oil on copepods have been reported in the order of 10 mg/L, toxicity increases substantially in the presence of natural ultraviolet (UV) radiation. Phototoxic effects to the copepods *Calanus marshallae* and *Metridia okhotensis* were observed at concentrations of ~2µg/L total dissolved PAC followed by 4-8 hours of exposure to ambient daylight. Responses included mortality, immobilization and discoloration of lipid sacs. Further experiments tested the interaction effects of various concentrations of PAC dissolved from weathered Alaska North Slope crude oil and subsequent exposure to sunlight with and without the UVB component to the copepods *Neocalanus flemingeri* and *N. plumchrus*. Phototoxicity was found to be a linear function of the product of light intensity and PAC concentration.

This research has shown that copepods could potentially provide a mechanism for the concentration of dissolved PAC from the water and its transfer into pelagic and benthic food chains.

Trophic dynamics of intertidal mudflats: Copper River Delta

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Vast expanses of intertidal mudflats serve as a critical link in the food web of nearshore communities along the southcentral Alaska coastline. One of the largest expanses of intertidal mudflats occurs in the Copper River Delta and southeastern Prince William Sound (Orca Inlet). The Delta's intertidal mudflats and network of sloughs serve as a critical connection between the Gulf of Alaska and the vast expanse of wetlands, rivers, lakes and glaciers in the Copper River basin. The rich abundance of benthic invertebrates residing within the mudflats provides foraging habitat for a variety of migratory and resident consumers. Building upon biological field surveys conducted from 2000-2002, we initiated a large-scale, multidisciplinary investigation of the intertidal, soft-bottom community of the Copper River Delta and southeastern Prince William Sound in 2003. The largely "bottom-up" approach supported by EVOS-GEM (physical/chemical parameters – phytoplantkon/epibenthic production – invertebrate production) is balanced by the "top-down" (predators – benthic invertebrates) focus of a companion project funded by the Prince William Sound Oil Spill Recovery Institute that examines predator dynamics.

Temporal changes in the food web are common as a result of the large number of highly migratory species that pass through the Delta. Included in these migrants are 3 species of salmon (sockeye, coho, and chinook) and 4 million shorebirds, the largest spring concentration in the Western Hemisphere. A gradient of community change exists from the more brackish, highly turbid areas influenced by the discharge of the Copper River, to the higher salinity, less turbid mudflats characteristic of southeastern Prince William Sound. This gradient, which influences primary production, can be used to examine the dynamics of intertidal communities under the influences of changing environmental conditions and may provide valuable insight in predicting community response to changes in local and regional forcing.

Fisheries Oceanography

Tuesday 13 January 2004 2:40 – 5:20 PM

Predictability of Prey Available to Free-Ranging Steller Sea Lions at Varying Spatial Scales
Michael F. Sigler, Scott M. Gende and David J. Csepp

An Examination of the Maturation of Walleye Pollock, *Theragra chalcogramma,* in the Eastern Bering Sea in Relation to Temporal and Spatial Factors
Jennifer Stahl and Gordon H. Kruse

Jellyfish impact on food web production and ecosystem structure in the southeastern Bering Sea
Alan Springer

Shallow Water Nearshore Fish Assemblages Around Steller Sea Lion Haulouts Near Kodiak, Alaska
Brenda Konar, Cathy Hegwer, Sue Hills and Kate Wynne

Reconstructing sockeye populations in the Gulf of Alaska over the last several thousand years
Bruce Finney

DNA analysis of the origins of Chinook salmon bycatch in the Alaska trawl fisheries
Tony Gharrett

Environmental Cues for Togiak Herring Spawning
Naoki Tojo, Gordon H. Kruse and David L. Musgrave

Integration of Marine Bird and Mammal Observations with the Pacific Continuous Plankton Recorder (CPR) Program: Seasonal Variability in Ecosystem Structure
William J. Sydeman, Peggy P. Yen, K. David Hyrenbach, Mike Henry, and Ken H. Morgan

POSTERS

Benthic Forage Species of Southeast Alaska
David J. Csepp

Distribution, Migration, and Relative Abundance of Juvenile Salmon in the Eastern Bering Sea
Edward V. Farley, Jr, James M. Murphy, Lisa Eisner, Jamal H. Moss and John H. Helle

Alaskan Groundfish Feeding Ecology: An OBIS Information System
Dale Kiefer, Vardis Tsontos, Frank O'Brien and Patricia Livingston

Ichthyoplankton Abundance, Distribution and Assemblage Structure in the western Gulf of Alaska during Autumn 2000 & 2001
Jennifer A. Lanksbury, Janet Duffy-Anderson and Kathyrn L. Mier

Distribution of Juvenile Pink Salmon in the Gulf of Alaska Relative to Surface Salinity, and Potential Implications for Foraging and Growth Opportunities
Jamal H. Moss, Edward D. Cokelet, Angela Middleton, Edward V. Farley, James Murphy, John H. Helle and David A. Beauchamp

Comparison of Analytical Techniques for Nutritional Quality Determination
L. Schaufler, C. Beck, D. Herman, J. Kennish and J. Vollenweider

Lipid Class and DNA Analysis as a Means to Examine Energy Allocation in Walleye Pollock (*Theragra chalcogramma*)
Johanna Vollenweider, Ron Heintz and Lawrence Schaufler

Topographic Effects on Pelagic Early Juvenile Walleye Pollock (*Theragra chalcogramma*)
M. Wilson, K. Mier, J.P. Pääkkönen, and K.B. Bailey

Fisheries Oceanography

Predictability of Prey Available to Free-Ranging Steller Sea Lions at Varying Spatial Scales

Michael F. Sigler[1], Scott M. Gende[2] and David J. Csepp[1]

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Steller sea lions face many constraints in finding patchily distributed food in a three-dimensional water space. We examined the characteristics of fish species at several spatial scales that may facilitate efficient foraging for free-ranging Steller sea lions in southeastern Alaska, and use observations of foraging sea lions to examine their effectiveness in locating high-energy prey patches. Herring and walleye pollock made up the dominant prey species in our study area. At the largest spatial scale, prey energy was highly variable across months, peaking in December and January during both years, due mostly to the presence of large schools of herring during these months. Combining all prey species, predictability varied among months, but was highest from November to February, regardless of spatial scale. However, the relationship between predictability and spatial scale differed among species. Predictability of herring, which were more patchily distributed, was generally asymptotic, peaking at a spatial scale of 11.0 km^2, whereas walleye pollock were most predictable at a scale of 2.1 km^2, reflecting a more uniform distribution. Steller sea lions were able to locate prey patches that were highest in energy density during most months. Predictability of high-energy prey, such as herring, at relatively small spatial scales may facilitate efficient foraging by Steller sea lions and play a central role in nutritional health for stable or increasing sea lion populations.

An Examination of the Maturation of Walleye Pollock, *Theragra chalcogramma,* in the Eastern Bering Sea in Relation to Temporal and Spatial Factors

Jennifer Stahl and Gordon H. Kruse

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Walleye pollock, *Theragra chalcogramma*, is the most numerous fish species and supports the most valuable commercial fishery in the eastern Bering Sea (EBS). Pollock maturity is an important parameter in calculations of spawning biomass used to set annual total allowable catches. However, maturity has not been assessed for EBS pollock since 1976, and potential interannual and geographic variation across continental shelf was not considered. Our main objective is to determine correct maturity schedules for EBS pollock. Maturity rates, age, and length (L_{50}) at 50% maturity will be estimated, and temporal and spatial variation will be identified for use in future stock assessments. Fish lengths and visual maturity stage data were collected from 4,996 and 5,201 pollock in 2002 and 2003, respectively, by quality control personnel aboard Pollock Conservation Cooperative (PCC) – member trawlers during the winter "A" fishing season. Ovary tissue was collected from 173 pollock for histological analysis to confirm appropriateness of visual staging methods. Logistic regression and geographic information systems (GIS) are being used to estimate potential geographic variation in maturity rates L_{50}. Also, maturity data collected by NMFS during 1976 and during more recent hydroacoustic surveys will be analyzed together with our 2002-2003 data to estimate temporal shifts. Histological analysis indicates that, of the ovaries visually classified as "developing," 16% were at immature oocyte stages and 84% were at stages corresponding to primary yolk sac or more advanced oocytes. Given vagaries of interpreting whether "developing" fish will spawn in spring of the current year on the EBS shelf with fish in more advanced maturity stages, statistical analysis was performed with two different assumptions – fish staged as "developing" were considered as either mature or immature. Based on preliminary results, we estimated L_{50} = 38 cm for 2002 and 2003 when developing was analyzed as immature, and L_{50} = 34 cm for 2002 and 35 cm for 2003 when developing was considered as mature. When completed, this study should provide valuable maturity data for estimation of spawning biomass. Inclusion of geographic or temporal variability in maturity will improve future stock assessments.

Fisheries Oceanography

Shallow Water Nearshore Fish Assemblages Around Steller Sea Lion Haulouts Near Kodiak, Alaska

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In the Gulf of Alaska at Kodiak Island, the decline of Steller Sea Lions and their lack of recovery have caused much concern. Since juvenile sea lions have limited dive depth profiles and potentially use nearshore fish to supplement their milk diets during weaning and to practice foraging techniques, a study to expand on the knowledge of fish availability around haulouts was undertaken. During 2001 and 2002, five SCUBA based surveys were conducted in the nearshore waters adjacent to two Steller sea lion haulouts at multiple depths to quantify seasonal fish diversity, abundance and species composition. Habitat information including macroalgal species identification, cover of understory, substrate, and benthic invertebrate faunal composition were taken concurrent with the fish surveys to determine similarity of fish habitat between all sites. Identical fish and benthic surveys were conducted at two control rocky headland areas, which had similar exposure, but were not historical Steller sea lion haulouts. The results of this study showed that while a similar fish assemblage was found at all sites, significant differences in fish composition and abundance existed between Steller sea lion haulouts and non-haulout controls. These differences are primarily due to an absence of rockfish and an abundance of greenling at the haul-outs sites. Also, patterns in fish assemblages were found at certain depths and seasons, particularly at the 9m, 15m and 21m depths during the summer sampling periods. Lower abundance of fishes and more even distribution patterns were seen in the winter months. Overall differences in the fish assemblages do not appear to be driven by algal habitat differences, but substrate may be playing a small role.

Fisheries Oceanography

Environmental Cues for Togiak Herring Spawning

Naoki Tojo[1], Gordon H. Kruse[1] and David L. Musgrave[2]

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Our goal is to understand underlining mechanisms and to develop predictive models for Pacific herring *(Clupea pallasi)* spawning activity in the Togiak District, Bristol Bay, Alaska. The Togiak herring fishery is the largest herring fishery in Alaska. Advance knowledge of herring spawning timing is essential to ADF&G fishery managers, fishermen, and processors because the fishery for roe-bearing herring takes place for a brief period in spring, the timing of spawning varies widely on an annual basis, and expensive field operations by managers and industry must be mobilized to operate in this remote area. We use Geographic information Systems (GIS) to develop spatially and temporally explicit models of several features of the Togiak herring population: (1) spawning timing, (2) spawning locations, (3) pre-spawning school dynamics, and (4) roe content. From our ADF&G collaborators, we collected historical aerial survey records of the distribution of pre-spawning herring schools and spawning locations, as well as supplementary data from other forage fish studies in the region. Geospatial databases have been created in formats compatible with ArcGIS. We have also collected various physical oceanographic and climatic data, primarily from IMS and NOAA. Variables were chosen for their potential influence on herring spawning dynamics. We have conducted exploratory analysis leading up to subsequent detailed statistical hypothetical testing of alternative models. Based on preliminary results, we speculate that thermal stratification is the most important oceanographic variable associated with herring spawning dynamics. Temperature may act in several ways, including regulation of the physiological processes associated with gonadal development and serving as a proximal cue for spawning. Here, we report on our project progress.

Fisheries Oceanography

Integration of Marine Bird and Mammal Observations with the Pacific Continuous Plankton Recorder (CPR) Program: Seasonal Variability in Ecosystem Structure

William J. Sydeman[1], Peggy P. Yen[1], K. David Hyrenbach[1,2], Mike Henry[1], and Ken H. Morgan[3]

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In 2002, we established an ocean-scale, inter-disciplinary, ecosystem-oriented monitoring program for the North Pacific Ocean and southern Bering Sea by integrating observations of marine birds and mammals with ongoing plankton studies along a 7,500 km "great circle" transect from British Columbia to Japan. With support from the NPRB, we have now completed 5 surveys along this transect, spanning June 2002 – October 2003. Studies reveal striking differences between seasons and basins (e.g., Gulf of Alaska vs. Bering Sea vs. western North Pacific) in marine bird, and to a lesser extent, marine mammal communities, and their associations with plankton communities and plankton abundance as derived by the CPR. We also found within-basin variation in marine bird communities. The seasonal dispersion of North Pacific seabirds appears to vary spatially and temporally in relation to satellite-sensed temperature (AVHRR) and chlorophyll (SeaWIFS) measurements. Seasonal variability in plankton-seabird-mammal community organization may have been typical or unusual due to the "state" of the ocean in 2002-2003, which was characterized by a moderate El Nino event. Future studies will allow us to investigate plankton to top predator ecosystem structure over multiple time scales from seasonal to interannual.

POSTER: Fisheries Oceanography

Benthic Forage Species of Southeast Alaska

David J. Csepp

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Steller sea lion prey studies have been conducted since May 2001 in southeastern Alaska. Acoustic surveys are conducted monthly in Lynn Canal and quarterly in Frederick Sound using a 38 kHz split-beam mobile system. Midwater trawl surveys are conducted quarterly using a 150 ft. headrope and small-mesh codend liner. Our surveys found a group of poorly studied yet abundant forage species associated with the bottom at depths greater than 100 meters. These species appear acoustically as a cloudy layer with myctophids as the dominant species with many other common and rare species.

POSTER: Fisheries Oceanography

Distribution, Migration, and Relative Abundance of Juvenile Salmon in the Eastern Bering Sea

Edward V. Farley, Jr, James M. Murphy, Lisa Eisner, Jamal H. Moss and John H. Helle

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Scientists from the NMFS, Auke Bay Laboratory, Ocean Carrying Capacity (OCC) program conducted surveys of juvenile salmon in the eastern Bering Sea during 2000 to 2003. The current research is part of a larger Bering Sea ecosystem study that includes member nations (Canada, Russian, Japan, and United States) of the North Pacific Anadromous Fish Commission (NPAFC), titled Bering-Aleutian Salmon International Survey (BASIS), developed to clarify the mechanisms of biological response by salmon to the conditions caused by climate change. The goal of OCC/BASIS is to understand mechanisms underlying the effects of environment on the distribution, migration, and growth of juvenile salmon along the eastern Bering Sea shelf. In particular, that ocean conditions in the first few months after juvenile salmon leave freshwater can significantly impact their ocean survival. Specific objectives of OCC/BASIS research cruises are to determine migration and distribution of juvenile salmon stocks, measure early marine growth, and determine relative abundance. Results of OCC/BASIS research cruises indicate that juvenile salmon are widely distributed across the eastern Bering Sea shelf; species specific distributional patterns of juvenile salmon can exist and that these distributional patterns are likely related to their principal prey sources (i.e age-0 pollock for juvenile sockeye and chum salmon, larval and juvenile sandlance for juvenile chinook); oceanographic characteristics can influence distribution and migration pathways (i.e. juvenile salmon appear to avoid areas of intense coccolithophore blooms); and the size and relative abundance of juvenile sockeye and chum salmon was largest during 2002 and 2003 and that age 1.0 juvenile sockeye salmon tend to comprise the largest component of catch during the Fall survey.

POSTER: Fisheries Oceanography

Alaskan Groundfish Feeding Ecology: An OBIS Information System

Dale Kiefer[1], Vardis Tsontos[1], Frank O'Brien[1] and Patricia Livingston[2]

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With support from Exxon Valdez Oil Spill Trustee Council, we will soon begin developing an OBIS (Ocean Biogeographic Information System) data node containing information characterizing the distribution and feeding ecology of Alaskan groundfish in relation to environmental parameters. Using established OBIS tools and protocols for Web-based access to biogeographic datasets, this information system will archive, analyze, and provide a means to distribute via the Internet information on the spatial and temporal distribution of a large number of groundfish and associated prey species sampled in the Gulf of Alaska, Aleutian Island waters, and the Bering Sea by NMFS Alaska Fisheries Science Center (AFSC). This biogeographic information system will include data on the gut contents of specimens as well as environmental information characterizing the habitats of the species. The system will also provide a detailed account of interspecific and environmental interactions that are integral to ecosystem-based fisheries assessment and management approaches. Biological databases used in this project will derive from AFSC, while environmental information will come from databases at the Pacific Marine Ecological Laboratory, AFSC and other on-line sources. Datasets employed are diverse in nature, and will include satellite imagery, hydrographic and fishery surveys data. Since the project has not yet begun, we will present at the symposium three examples of our recent projects, two Alaskan projects, SALMON and Ghost Net, and our OBIS mapping server. These projects are good examples of the Alaskan Groundfish Feeding Ecology Information System we will start in May.

POSTER: Fisheries Oceanography

Ichthyoplankton Abundance, Distribution and Assemblage Structure in the Western Gulf of Alaska during Autumn 2000 & 2001

Jennifer A. Lanksbury, Janet Duffy-Anderson and Kathyrn L. Mier

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High spring abundance of ichthyoplankton in the Shelikof Strait sea valley, Gulf of Alaska has been well documented, but comparatively little work has been done to characterize fall assemblages in this region. In September 2000 and 2001, Tucker trawls (333 μm mesh) were conducted as part of two surveys designed to sample young of the year and forage fishes. Ichthyoplankton data from these collections were analyzed to 1. describe ichthyoplankton assemblages in the Shelikof sea valley in fall (September), 2. examine interannual variation in assemblages between 2000 and 2001 and 3. relate observations to oceanographic conditions. Taxa with the highest frequency of occurrence in 2000/2001 included *Mallotus villosus* (94/87%), *Hexagrammos lagocephalus* (57/45%), *Sebastes spp.* (35/47%) and *Bathymaster spp.* (27/57%). Through the use of clustering techniques and ordination, three identifiable larval assemblage structures were found. Near shore and offshore assemblages appear well defined in both years, while a loosely associated assemblage occurs in the center of lower Shelikof Strait sea valley. The spatial distribution of these assemblages is explored in relation to bathymetry, flow regime and temperature. Links between species abundance/distribution and available food sources will also be explored. Future studies will include a comparison to the spatial distribution of larval fish species around southeast Kodiak Island, including historical (fall 1978) and recent (fall 2002) ichthyoplankton catch data.

POSTER: Fisheries Oceanography

Distribution of Juvenile Pink Salmon in the Gulf of Alaska Relative to Surface Salinity, and Potential Implications for Foraging and Growth Opportunities

Jamal H. Moss[1], Edward D. Cokelet[2], Angela Middleton[1], Edward V. Farley[1], James Murphy[1], John H. Helle[1] and David A. Beauchamp[3]

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NOAA's R/V *Miller Freeman* and R/V *Alpha Helix* participated in a coordinated oceanographic and fisheries sampling effort on the Alaskan continental shelf near the Seward Line on 30-31 July 2003. On this occasion the brackish Alaska Coastal Current (ACC, 27 psu surface salinity) ran near shore and was separated from saltier midshelf water (31 psu) by a frontal region (29 psu) a few kilometers in width. Sampling in all three zones consisted of CTD casts, Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS) hauls and juvenile salmon trawls. Juvenile pink salmon diet was quantified onboard *Miller Freeman*, and potential zooplankton prey items were collected via MOCNESS onboard *Alpha Helix*. The observations were designed to determine how juvenile pink salmon are distributed relative to surface salinity and to assess the energetic costs and/or benefits associated with physical and biological conditions across a salinity gradient. The working hypothesis was that juvenile pink salmon would be confined to the ACC and would not be found farther offshore. However, juvenile pink salmon were found both in the ACC and offshore thus negating the hypothesis. The species composition and abundance of zooplankton from samples taken from each oceanographic station will be quantified and used to assess relative consumption demand in relation to relative prey supply. Juvenile pink salmon catch, size, diet, and thermal experience data were used in a bioenergetics analysis to estimate site-specific consumption demand.

POSTER: Fisheries Oceanography

Comparison of Analytical Techniques for Nutritional Quality Determination

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We compared various analytical methods used to assess the nutritional composition and quality of Steller sea lion and other marine predator diets. Diet quality determination may include measurement of lipid and protein content, fatty acid composition, and proportions of lipid types (triacylglycerol, phospholipid, etc.) in prey items. However, there are a variety of analytical instruments and protocols available for these measurements and they can provide variable results. Consequently, analytical results for a given sample may differ between laboratories. We analyzed standard reference materials in several laboratories using different protocols and instruments. Results were compared for precision and accuracy both within and between analysis labs. We observed protocol-dependent differences in proximate composition, lipid class distribution, and fatty acid profile within laboratories and differences among laboratories using the same protocols. Understanding the scale of variation due to differences in analytical methods is a critical consideration when compiling and comparing data between laboratories and published literature.

POSTER: Fisheries Oceanography

Lipid Class and DNA Analysis as a Means to Examine Energy Allocation in Walleye Pollock (*Theragra chalcogramma*)

Johanna Vollenweider, Ron Heintz and Lawrence Schaufler

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Bioenergetic condition of forage fish plays an important factor in life history strategies and survival. Juvenile fish must allocate energy between conflicting demands for growth and storage, while adults must acquire energy for reproduction. We examined how energy was allocated in walleye pollock (*Theragra chalcogramma*) by measuring the proportion of calories allocated to structural elements and triacylglycerols. In addition we monitored instantaneous growth by measuring RNA:DNA ratios of whole fish homogenates. Three age classes of pollock (young-of-the-year, juvenile, and mature) were examined over the period of a year. Different energy allocation strategies were observed among age classes. At any time during the year energy stores (triacylglycerols) were greatest for the oldest fish. Juveniles and young-of-the-year demonstrated a tightly coupled inverse relationship between growth and energy storage, with peak growth in the summer and peak energy stores in the winter. Growth of mature pollock declined over the summer and increased through the winter and into spring. Energy stores of mature pollock followed a seasonal pattern similar to that of growth, indicating that energy storage was no longer coupled to growth. These data suggest immature fish must sacrifice either growth or energy storage while mature pollock are able to maintain both processes simultaneously.

POSTER: Fisheries Oceanography

Topographic Effects on Pelagic Early Juvenile Walleye Pollock (*Theragra chalcogramma*)

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Small pelagic fishes often play a pivotal role in structuring ecosystem food webs due to their mid-level trophic position. As zooplanktivores, these 'forage' fishes are sensitive to geographic variation in hydrography (e.g., fronts, localized upwelling) that induce spatial variation in zooplankton composition and abundance. In the Gulf of Alaska, principal forage-fish species include juvenile walleye pollock (*Theragra chalcogramma*), capelin (*Mallotus villosus*), and eulachon (*Thaleichthys pacificus*). Our poster illustrates some of our research, funded in part by the Steller Sea Lion Research Initiative and the North Pacific Research Board, to better understand geographic and annual variation in forage-fish productivity. During the first two years of study, 2000 – 2001, the biomass of early juvenile (age-0) walleye pollock was highest in areas of intermediate (100 – 200 m) water depth. However, no consistent associations were detected between age-0 biomass and water temperature, salinity, potential prey biomass, or potential competitor biomass. Similar analyses are being conducted on the biomass of capelin, eulachon, and older walleye pollock. Data available from September 2003 will be included. In addition, geographic variation in fish diet and water temperature is being examined using bioenergetics models to estimate fish growth and prey consumption in relation to prey standing stock and hydrographic features.

Killer Whales and Steller Sea Lions

<u>**Tuesday 13 January 2004 7:00 – 9:00 PM**</u>

Kill Rates and Prey Preferences of Southeast Alaskan Transient Killer Whales (*Orcinus orca*)
Marilyn E. Dahlheim, Dave K. Ellifrit and Paula A. White

Feeding Ecology of Transient Killer Whales in the Northern and Eastern Gulf of Alaska
Janice Straley, Craig Matkin, Dena Matkin, Lance Barrett-Lennard and Christine Gabriele

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Commercial Whaling And "Whale Killers": A Reanalysis of Evidence for Sequential Megafauna Collapse in the North Pacific
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Are killer whales the main reason for the decline of the marine mammal population in the North Pacific: a Russian perspective
Alexander Burdin

POSTERS

Causes of Early Pup Mortality at a Steller Sea Lion Rookery (*Eumetopias jubatus*) in the Northern Gulf of Alaska
John Maniscalco and Shannon Atkinson

Contaminant Levels in Russian Killer Whales (*Orcinus orca*)
Matt Myers, Alexander Burdin and Shannon Atkinson

Kill Rates and Prey Preferences of Southeast Alaskan Transient Killer Whales (*Orcinus orca*)

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Killer whale (*Orcinus orca*) predation has been implicated in the decline of harbor seals (*Phoca vitulina*), Steller sea lions (*Eumetopias jubatus*), and sea otters (*Enhydra lutris*) in western Alaska. Until now, calculation of kill rates for cetaceans have rarely been attempted due to inherent difficulties in maintaining contact with the predators, and the lack of persistence of prey remains following a kill. Empirical data on prey preference is rare even for terrestrial studies, yet both rate and preference are vital to describing predator-prey relationships. Between 1991 and 2003, killer whale surveys were conducted each year throughout the inland waterways of Southeast Alaska. Utilization of a dedicated research vessel over the thirteen-year period provided us with the unique opportunity to follow killer whales over extended periods of time. Herein, we present empirical data on transient killer whale predation gathered during 285.5 hours of direct observation representing 34 predation events. Based on these data, a kill rate of 0.78 prey items/24-hr period/whale was calculated. Transient killer whales targeted several species of marine mammals and sea birds. We compare kill rates of killer whales with data from the literature on terrestrial group-hunting species, and discuss whether optimal foraging theory applies to killer whales. This is the first attempt to quantify kill rates of any marine mammal through continuous and direct observation of predatory behavior. Information presented here will hopefully contribute to assessing the impact that killer whales may be having on marine mammal populations in western Alaska.

Feeding Ecology of Transient Killer Whales in the Northern and Eastern Gulf of Alaska

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In the northern Gulf of Alaska (NGOA, Prince William Sound-Kenai Fjords), we identified three haplotypes and two populations of transient killer whales: 1) AT1, which totaled 22 whales in the 1980s have since declined to 8 whales and 2) GOA, which consists of whales with two similar haplotypes and totaled 38 whales. In the eastern GOA (EGOA, northern southeastern Alaska) there are, also, transient killer whales with three haplotypes and two populations: 1) GOA (both haplotypes) and 2) West Coast (WC), which range further south, as well. There were 19 GOA and 123 WC transient killer whales seen in the EGOA during our study over the past 20 years. The GOA transients were sighted first in the EGOA in 1995. This may reflect a movement into this area, perhaps from the NGOA, where only 8 whales were seen in recent years.

In the NGOA, about 10% of encounters were with transients and less than 5% of the number photographed was transient killer whales. In the EGOA, 71% of the encounters were with transients and 57% of the total number photographed was transient killer whales.

In the NGOA, there may be diet specialization by population. AT1s were seen killing mostly harbor seals (34%) and Dall's porpoises (38%) out of 32 observed kills since 1984. GOA transients were seen killing Steller sea lions 5 times and Dall's porpoises once since 1997. In the EGOA, insufficient data exists to discern if there are diet preferences for each population. Predation events (kills) were observed 76 times since 1980. Harbor seals were killed most often (29%) with Steller sea lions (18%), harbor porpoise (17%) and Dall's porpoise (7%) killed to a lesser extent. In both areas, sea birds, sea otters and large whales were harassed but rarely killed.

The observations of higher numbers of transient killer whales in the EGOA, where mostly increasing prey populations exist, argues against killer whale predation as the cause of the western Alaska Steller sea lion decline, although it can not be ruled out that predation by killer whales is impeding the recovery of this population.

Abundance and Distribution of Killer Whale Ecotypes in Central and Western Alaska (Kenai Fjords to Central Aleutians)

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Information on the abundance and distribution of killer whales in central and western Alaska is required to assess the impact of killer whale predation on other marine mammal populations and evaluate the interaction between killer whales and commercial fishing activities. Although killer whale population size and stock structure is relatively well known for the waters of southeastern Alaska and Prince William Sound, very little information exists for killer whales inhabiting Alaskan waters west of Kodiak Island. We present results from three years (2001-2003) of an ongoing study to provide baseline data on the distribution, abundance and stock structure of killer whales in nearshore (<30nm) waters from the Kenai Fjords in the east to Tanaga Pass in the central Aleutians. Dedicated large-ship surveys, combined with opportunistic sighting effort during other research cruises, have provided data from 173 different killer whale sightings. It was possible to approach the whales on 107 of these sightings (termed "encounters), during which we obtained more than 20,000 identification photographs and 88 tissue samples using remote biopsy techniques. Based on analysis of these photographic and genetic data, three distinct killer whale ecotypes have been found to use this region. These ecotypes overlap in their distribution, but appear to differ in their feeding ecology in a manner consistent with observations from other areas in the NE Pacific. "Residents" and "offshores" are thought to feed primarily on fish, in contrast to "transients" that have only been observed to prey upon other marine mammal species. The majority (81) of encounters have been with resident whales, in contrast to only 3 groups of offshores and 23 groups of transients. Killer whales were always encountered in groups, although the ecotypes differed in their grouping patterns. Offshores were encountered in large groups (median 40, range 13-60), residents in groups averaging 18 (range = 4-90) individuals, and transients in smaller groups of around 4 (range 2–30) individuals. To account for differing detectability of these ecotypes, we are currently estimating abundance using two different approaches: distance sampling based on line-transect sightings data and mark-recapture analysis based on photographic identification data.

Whale Killers? Transient Killer Whales in the Eastern Aleutians

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During June, July and August of 2002 and 2003 we operated two 32' vessels for total of 60 days per vessel in the June, July, and August from Unimak Island to Umnak Island in the Eastern Aleutians investigating killer whale population structure and ecology. In May 2003, an additional 20 days of surveys were conducted in the and False Pass/Unimak Pass region. Goals included the 1) separation of residents, transient and offshore ecotypes using association, genetics, and acoustics, 2) enumerating each ecotype using photoidentification, and 3) examining distribution and feeding habits. During the June through August surveys we found far more residents (over 500 individuals identified) than transients (41 individuals identified). However during 12 encounters in May 2003 in the False Pass/Unimak Pass region only transient killer whales were observed and photographed. Despite poor sea conditions, 148 killer whales were photographed during the encounters, with a total of 85 unique individuals, and only 3 of these whales matched individuals that were seen in the region in summer months of 2002-2003. Group sizes were as large as 28 whales. Biopsies indicated they were of mixed transient haplotypes (GOA type1, and AT1 type). On four occasions the whales appeared to be feeding on submerged whale carcasses, two samples from these feeding bouts have been genetically identified as grey whales. Carcasses were apparently on the bottom in relatively shallow water and we suspect that they were revisited by the whales over a period of days. In summer transient killer whales have been seen to prey upon or harass northern fur seals, Dall's porpoise, minke whales, and humpback whales although sea conditions have made observations challenging. Steller sea lions are notably lacking from the list of prey items, despite our operations adjacent to rookeries and haulouts in the region. The spring predation on grey whales suggests another instance of seasonal feeding specialization by killer whales. Historical information from local residents of False Pass suggest that this predation pattern has occurred for many years.

The Collapse of Pinniped and Sea Otter Populations in the North Pacific Ocean: An Ecological Legacy of Industrial Whaling?

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Harbor seal, Steller sea lion, and sea otter populations have sequentially collapsed over large areas of the northern North Pacific Ocean and southern Bering Sea during the last several decades. A variety of evidence indicates that top-down forcing associated with increased predation by killer whales drove the sea otter collapse. In contrast, a bottom-up nutritional limitation mechanism induced by physical oceanographic changes or competition with fisheries has long been thought to be largely responsible for the pinniped declines. With recent reports suggesting that the weight of evidence for the population change in sea lions is more consistent with top-down forcing, we propose that killer whale predation may have also contributed to the pinniped declines. We suggest that the decimation of the great whales by post-World War II industrial whaling greatly reduced the sustainable biomass of marine mammals in the North Pacific ecosystem, thus causing the foremost natural predator of marine mammals, transient killer whales, to begin feeding more intensively on the smaller and less sustainable pinnipeds and sea otters. The timing of these events, information on the abundance, diet, and foraging behavior of both predators and prey, and feasibility analyses are consistent with this hypothesis. Daily caloric requirements of killer whales, caloric value of prey items, and demographic changes in marine mammal populations were used to assess the potential impact of killer whales on sea otter and Steller sea lion populations in the Aleutian Islands. The results show that fewer than 40 killer whales could have caused the recent Steller sea lion decline in the Aleutian archipelago; a pod of 5 individuals could account for the decline in sea otters and the continued suppression of sea lions. With the collapse of the historical prey base of killer whales due to human whaling, this study suggests that a sequential dietary switch from high to low caloric value prey could initiate the observed declines.

Commercial Whaling And "Whale Killers": A Reanalysis of Evidence for Sequential Megafauna Collapse in the North Pacific

Paul Wade[1], Lance Barrett-Lennard[2], Nancy Black[3], Robert Brownell Jr.[4], Vladimir Burkanov, Alexander Burdin, John Calambokidis, Sal Cerchio[5], Phil Clapham[6], Marilyn Dahlheim[1], John Ford, Nancy Friday[1], Lowell Fritz[1], Jeff Jacobsen[8], Thomas Loughlin[1], Mark Lowry, Craig Matkin[9], Dena Matkin[10], Amee Mehta[11], Sally Mizroch[1], Marcia Muto[1], Dale Rice[1], Donald Siniff[12], Robert Small[13], Gretchen Steiger, Janice Straley[14] and Glenn Van Blaricom[15]

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Springer et al. (2003) hypothesize that sequential declines in North Pacific populations of seals, Steller sea lions, and sea otters were due to increased predation by killer whales, following the removal by commercial whaling of baleen whales as the killer whales' primary food source. Regardless of whether or not killer whales have caused or contributed to the decline of species such as sea otters, we conclude there is little evidence to suggest this would have occurred due to a lack of available cetacean prey. We re-examined trends in abundance and biomass of potential marine mammal prey of killer whales in 3 regions (Aleutians/Bering Sea, Gulf of Alaska, and S.E. Alaska to California). We suggest that top-down forcing by killer whales is an unlikely common explanation for all of the reported declines, for several reasons. First, the spatial and temporal patterns of regional population trends are more complex than Springer et al. suggest and in many cases are inconsistent with their killer whale hypothesis. Many pinniped and sea otter populations are stable or increasing in areas where extensive whaling occurred and large numbers of transient killer whales exist. Two points are most striking. First, since commercial whaling ceased all prey species have increased substantially along the west coast of the U.S. and Canada despite the presence of a large mammal-eating killer whale population. Secondly, in the Bering Sea and Aleutian Islands region, the substantial biomass of fur seals available throughout the time period provides no justification under the hypothesis for a switch to sea otters. Among whales, gray

whales have increased steadily since the 1940s, populations of humpback and fin whales have increased substantially, and minke whales have likely always been abundant. Thus, to suggest that baleen whales have been unavailable as potential prey during much of the period concerned is not correct. The hypothesis also ignores small cetaceans that are known killer whale prey but have remained abundant in much of the eastern North Pacific (notably Dall's porpoise). Finally, we question the assumption that adult large whales were ever a significant prey item for killer whales in the high-latitude habitats in which the purported declines have occurred. Evidence from field observations, stomach contents, and from scarring on baleen whales strongly suggests that when killer whales in these regions attack whales, they prey primarily upon minkes and on calves of species such as gray and humpback whales.

POSTER: Killer Whales and Steller Sea Lions

Causes of Early Pup Mortality at a Steller Sea Lion Rookery (*Eumetopias jubatus*) in the Northern Gulf of Alaska

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A small (ca. 80 breeding animals) Steller sea lion rookery has been studied over the years 2001 through 2003 using a remote-video camera system. At least half of the breeding females were tracked during each breeding season using natural markings and several measures maternal investment were recorded. Estimates of pup loss during the first few months of life were consistent from year to year at 19.2%, 20.3% and 19.7% from 2001 through 2003, respectively. However, the causes of these losses varied. During 2001, pup losses were attributed solely to orca predation. In 2002, orca predation was not a factor and 11 out of 13 pup losses during that season were attributed to storm waves during the month of June. Orca predation and an unknown factor killed most of the pups in 2003. The unknown factor caused seven deaths in pups aged 2 days to approximately 2 months of age. As an interesting coincidence in 2003, several pups also had lesions consistent with a type of calicivirus on their flippers to a much greater extent than observed in previous seasons. Only one death in each of 2002 and 2003 was attributed to abandonment. Early mortalities of 20% in Steller sea lions are not unusual although a combination of the above causes in any one year may result in a greatly diminished cohort.

Contaminant Levels in Russian Killer Whales (*Orcinus orca*)

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Recently, much attention has been focused on contaminants in killer whales (*Orcinus orca*) in the eastern North Pacific Ocean. Studies done with animals from Washington State to the Gulf of Alaska have found contaminants loads to be high in this apex predator. In order to identify if animals in the western Pacific were also high, opportunistic contaminant sampling of orcas in the Starichkov Island area near Eastern Kamchatka in the Russian waters of the North Pacific Ocean was completed on 13 animals during the summer season of 2002. When animals were encountered, a blubber biopsy was removed by a dart shot form a crossbow and the animals were photographed. Location, age (as adult, juvenile, young, calf and unknown), gender and behavior were noted. Blubber samples were analyzed for toxicity caused by the accumulation of organochlorines (OCs), such as polychlorinated biphenyls (PCBs) and 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane or dichlorodiphenyltrichloroethane (DDT). The procedure employed was a HPLC/PDA (high-performance liquid chromatography with photodiode array detection) method that was developed to rapidly screen for toxic "dioxin-like" CBs and congeners. Sum PCBs ranged from 12 to 3400 ng/g lipid weight with an average load of 678 ± 276 ng/g lipid weight. On average DDT levels were higher with an average of 834 ± 329 ng/g lipid weight and a range of 22 to 3700 ng/g lipid weight. In other studies, mammal eating whales had considerably higher levels of all contaminants. As it is unknown if these whales were mammal eaters or fish eaters, a direct comparison can not yet be made. Still, levels in the whales investigated are relatively low suggesting that animals in the western North Pacific may not be exposed to as much pollution as their eastern counterparts.

Species at Risk

Wednesday 14 January 2004 8:00 – 9:40 AM

Eider Update
Tuula Hollmén

Status and Trend of Selected Marine Mammals in Alaska: Steller Sea Lions, Northern Fur Seals, Cook Inlet Beluga Whales and North Pacific Right Whales
J. Ward Testa, Rolf R. Ream, Rod Hobbs and Paul R. Wade

Preliminary Results of At-Sea Capture and Satellite Tracking of Short-Tailed Albatrosses in Alaska
Gregory Balogh and Robert Suryan

Capture and Holding of Juvenile Steller Sea Lions: The Transient Project
Jo-Ann Mellish, Shannon Atkinson and Michael Castellini

Sea Otter Populations in Alaska: a Focus on Southwest
Angela M. Doroff, Douglas M. Burn, Verena Gill, and Rosa Meehan

POSTERS

Pregnancy Rates of Harbor Seals in Alaska
Anne Hoover-Miller, Maki Kurihara, Suzanne Conlon, Kendall Mashburn and Shannon Atkinson

Geological Structuring of Subtidal Habitat and Its Influence on the Foraging Strategy of Sea Otters: Simpson Bay, Prince William Sound, Alaska
Christian Noll, Timothy Dellapenna, Andrea Gilkinson, Randall Davis, Heidi Pearson and Fred Weltz

Magnitude and Sources of Variability in Steller Sea Lion (Eumetopias jubatus) Prey Quality
Johanna Vollenweider and Ron Heintz

Eider Update

Tuula Hollmén

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Two of the four species of eiders found in Alaska are listed as threatened under the U.S. Endangered Species Act. Spectacled eiders (*Somateria fischeri*) were listed in 1993 due to significant declines in numbers of nesting birds in western Alaska, and the Alaska breeding population of Steller's eiders (*Polysticta stelleri*) was listed in 1997 due to reductions in its nesting range. Additional declines have been observed within common eider and king eider populations, raising concerns about the status of all species of eiders in the northern hemisphere. The causes of the declines and reduced breeding range are largely unknown. Furthermore, relatively little is known even about the basic biology of eiders as compared to other, more intensively studied waterfowl.

Eiders are associated with marine environments of the northern hemisphere, and winter, molt, and nest in geographically remote locations Recent declining trends in numbers of eiders and other species of sea ducks have lead to increasing research efforts to understand current threats to wild populations and to aid in their recovery. Several factors affecting the survival of eiders have been identified and several recovery actions have already taken place, including the designation of critical habitat for both species of threatened eiders by the U.S. Fish and Wildlife Service in 2001.

Also in 2001, the Alaska SeaLife Center (ASLC) initiated an eider research program with a focus on research on Steller's and spectacled eiders. The specific goals of the ASLC eider program are to develop and maintain a captive eider program, to develop laboratory and field projects investigating factors affecting eider populations, and to serve the needs of the federal and state programs and the eider recovery teams. The ASLC has established captive sea duck facilities that currently hold flocks of three species of eiders, including both species of the threatened eiders. Ongoing research focuses on eider reproduction and artificial propagation techniques, nutritional physiology and foraging, endocrinology, contaminants, and disease ecology.

Species at Risk

Status and Trend of Selected Marine Mammals in Alaska: Steller Sea Lions, Northern Fur Seals, Cook Inlet Beluga Whales and North Pacific Right Whales

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The trends and current status of four prominent marine mammal populations considered at risk in Alaska are reviewed. The western stock of Steller sea lions, considered endangered under ESA, showed some evidence of arrested decline, or even slight recovery in parts of its range in the most recent surveys (2002), but continued decline in the far west. Production in northern fur seals, depleted under the MMPA, declined on the Pribilof Islands at a 5% annual rate from 1998-2002 after nearly 20 years of relative stability. Since its inception in 1982, the small population of fur seals at Bogoslof Island has grown rapidly, but has not been surveyed since 1997 when >5,000 pups were born. The small population of beluga whales in Cook Inlet was listed as depleted under the MMPA, and the subsistence harvest was voluntarily curtailed. Surveys since 1999 indicate that the population is no longer in decline, but it is too early to be sure that a recovery is underway. We have little information to assess the status of Northern right whales, but they are highly endangered (probably < 100). Small numbers, mostly of males, have been observed in the Bering Sea in recent years, and the first calf was seen in 2002.

Preliminary Results of At-Sea Capture and Satellite Tracking of Short-Tailed Albatrosses in Alaska

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The Short-tailed Albatross (*Phoebastia albatrus*) Recovery Team has identified as a research priority the determination of important marine habitats for this highly pelagic species. Without this information, we cannot fully understand spatial and temporal interactions between short-tailed albatross and commercial fisheries that occasionally take this species in their gear. Investigation into the distribution and movement of large, pelagic avian species is best addressed using satellite telemetry. However, conducting satellite tracking studies of short-tailed albatross is challenging because access to the animals is difficult. Disturbance of birds on the primary breeding colony in Japan (Torishima) is restricted. Capture of birds at sea is less restricted, but has never been successfully attempted.

We undertook at-sea capture efforts to deploy PTTs on short-tailed albatrosses in the Aleutian Islands, Alaska, in August 2003. The two-week cruise included eight full or partial work days (60 hrs total), mostly in Seguam Pass (eastern Aleutians). We recorded 35 short-tailed albatross sightings of at least 17 different individuals. We captured and deployed PTTs on four birds; two hatch year birds, one second year bird, and one adult (23-year-old). Within 3.5 months, we obtained over 2,200 locations, primarily from three birds. Two of the PTTs were still operational as of 24 November, 2003. Most position fixes were in the Bering Sea and along the Aleutian Islands. In November, 2003, two of the birds began moving south on opposite sides of the Pacific Ocean; with position fixes off the Kurile Islands (Russia), British Columbia (Canada), and Washington and Oregon (USA).

Species at Risk

Capture and Holding of Juvenile Steller Sea Lions: The Transient Project

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It is widely recognized that the western stock of the Steller sea lion (*Eumetopias jubatus*) has been steadily and rapidly declining over the past few decades. Current research suggests that the juvenile age class (1-4yr) may be the most vulnerable cohort due to nutritional stress and other compounding factors. Difficulties faced by researchers include remote habitat, large size, and the tendency for this age class to remain at sea for extended periods. Animals sampled in the wild are typically only caught once, providing only a static view in time. There are no currently available captive research animals within this age group in the United States. The goal of the transient project is to provide a unique and critical resource to researchers in this field, that is, access to juvenile Steller sea lions for comprehensive longitudinal research. Groups of up to four juvenile Steller sea lions are transported from the wild to the specialized ASLC holding facility for periods of up to three months, during which time they are involved in numerous complementary projects designed to assess the health status, body condition, stress response, reproductive endocrinology, epidemiology, nutritional capacity and foraging behavior of juvenile Steller sea lions. Animals will also be monitored post-release via various internal and external data loggers. The transient juvenile program currently integrates twelve funded projects with ten principal investigators and seven institutions.

Sea Otter Populations in Alaska: a Focus on Southwest

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Sea otters have exhibited a remarkable capacity to recolonize former range after having been depleted to only 1,000-2,000 otters world-wide. During the 1980s, the sea otter population in Alaska was growing rapidly. Between 1986 and 2001, however, the sea otter population declined dramatically throughout southwest Alaska. The area of decline ranges from the Near Islands to the Kodiak archipelago. During the 1990s, the sea otter population in the Aleutian Island chain declined at a rate of 17.5% yr^{-1} and overall, counts decreased by 70% throughout the archipelago by 2000. In 2000, we estimated the population to be only 10% of the potential carrying capacity, representing an estimated loss of 65,000 sea otters from the archipelago in 8yrs. Between 2000 and 2003, counts declined by 63% at 6 index sites in the west and central Aleutian Island chain. Based on surveys conducted in 2000 and 2001 of the Alaska Peninsula, the sea otter population declined by 27-49% along the northern Peninsula and 93-94% along the southern Peninsula since 1986. Sea otters were concentrated in bays and lagoons of the Peninsula, whereas historically, large rafts were distributed offshore as far as 50km. In the Kodiak archipelago, sea otter abundance estimates have declined 56% at an estimated rate of 6.7% yr^{-1} since 1989. As of 2001, there has been no population range expansion documented and overall density has decreased in the nearshore habitat in the Kodiak archipelago. In the region of decline, sea otter forage habitat is highly variable (rocky, mixed, and soft sediment substrates) and the population status (relative to equilibrium density) was varied. Sea otter population declines are similar in all areas surveyed in the following ways 1) severity, 2) the decline occurred within similar time periods, and 3) severe declines of pinniped populations have occurred in the same general region. In 2001, the U.S. Fish and Wildlife Service designated the southwest sea otter population stock is a candidate species for listing under the Endangered Species Act. The population declines in southwest Alaska are one of the most significant conservation issues in our time for the northern sea otters.

POSTER: Species at Risk

Pregnancy Rates of Harbor Seals in Alaska

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Age-specific pregnancy rates and incidences of reproductive failures in seals affect population growth rates. We examined 54 reproductive tracts, obtained from subsistence harvested seals between January 2000 and May 2002 by the Alaska Native Harbor Seal Commission's (ANHSC) Biosampling Program. A portion of our study assessed age-specific pregnancy rates by gross dissection. Ages of seals were determined by sectioning of canine teeth (ADF&G, unpublished). Ten tracts that were insufficiently complete or did not have associated age data were not included in this analysis. 26 reproductive tracts were obtained from Prince William Sound, and 18 were from other locations in Alaska ranging from Bristol Bay to southeast Alaska.

Pregnancy rates for the 26 seals in Prince William Sound were 0% for 0-2 year olds (n=8), 50% for 3-year-olds (n=2), 67% for 4-year-olds (n=3) and 100% for seals 6 years and older (n=13). Primiparous seals ranged from 3-6 years old. Reproductive failure occurred in one 4-year-old seal that showed evidence of a uterine bacterial infection.

Pregnancy rates for the 18 seals harvested elsewhere in Alaska also showed pregnancy rates of 0% for 0-2 year olds (n=9). None of the 3-year-olds (n=3) were pregnant and two showed evidence of vaginal infections. All of the 7-14 year-old seals harvested after implantation in October (N=3) were pregnant but the pregnancy status of an additional 7-year-old could not be determined as implantation may not have occurred. A single 26-year old showed a failed pregnancy.

These data represent seals across a broad geographic range. Although samples sizes are too small for conclusive comparisons, they do not suggest marked differences in pregnancy rates from previous studies. Of the 3-4 year-olds (n=8) reaching reproductive maturity, 3 showed evidence of vaginal or uterine infections. The continued contributions of reproductive tracts through the ANHSC biosampling program are essential for more comprehensive assessments of current reproductive rates and causes of reproductive failures in seals throughout Alaska.

POSTER: Species at Risk

Geological Structuring of Subtidal Habitat and Its Influence on the Foraging Strategy of Sea Otters: Simpson Bay, Prince William Sound, Alaska

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Beginning in the summer of 2001, Simpson Bay, in Prince William Sound Alaska, has been the site of an on-going interdisciplinary investigation of the foraging strategies of sea otters. By bringing together a team of marine biologists and geologists, we have coupled extensive observational analyses of sea otter behavior with a geophysical and geological investigation of the bay. The result is a comprehensive framework for investigating sea otter/benthic community interactions in the subtidal environment. Simpson Bay is part of an interconnected array of fjords, bays, islands and open water which was selected as a study site for its high density of sea otters, its protected open water area and the logistical support provided by the Alice Cove Research Station. Fjord morphology within the bay creates an estuarine environment with a spring tidal range in excess of 5 meters.

The geophysical component of the study combined multiple techniques to characterize subtidal habitats. A side scan sonar mosaic was generated for the entire subtidal area of the bay, along with a high-resolution bathymetric map. Sonar images in shallow water environments show high backscatter, which indicates coarse sediments, bedrock outcrops, and moraine deposits. Sonar images of deeper portions of the bay show low backscatter and are associated with fine grain material. In addition, 275 surface sediment grab samples were collected to investigate the surficial geology and delineate habitat heterogeneity in the fjord. Although Simpson Bay has not had a tidewater glacier in recorded time, most sediment samples contain large, angular clasts suggesting ice rafted glacial debris. High-resolution seismic data from a CHIRP sub-bottom profiler and short (1-2m) cores will be used to create a temporal record of sedimentation rates, large-scale events and glacial retreat. The biological component of the study is an ongoing effort to correlate sea otter feeding strategies to the subtidal environment. Preliminary results indicate that depth most influences sea otter feeding strategies. Further investigation needs to be undertaken to look at the attributes of Simpson Bay's benthic community that allows it to support such a large prey population in such a small area.

POSTER: Species at Risk

Magnitude and Sources of Variability in Steller Sea Lion (Eumetopias jubatus) Prey Quality

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Recent population declines of piscivorous predators across multiple taxa in the North Pacific Ocean and Bering Sea have led to the investigation of nutritional stress as a plausible cause. Bioenergetic models, which are particularly sensitive to prey quality inputs, require detailed information regarding the magnitude and sources of variability of prey body composition. Proximate composition and energy density of several important Steller sea lion (*Eumetopias jubatus*) prey species, including walleye pollock (*Theragra chalcogramma*), Pacific herring (*Clupea harengus*), eulachon (*Thaleichthys pacificus*), capelin (*Mallotus villosus*) and Pacific hake (*Merluccius productus*) were evaluated through a systematic experimental design. For a given species of fish, proximate composition varied significantly, particularly lipid content which varied by an average of 35-fold among individuals within a species, with over 100-fold differences among individual mature pollock. Seasonal effects primarily accounted for variability within species. A general cyclical trend of body composition was observed, with increasing lipid stores (and consequentially energy density) throughout the summer coincident with intense feeding activity, peaking in the fall or winter, and subsequently declining to a minimum immediately prior to or following spawning. Shifts in peak condition among species caused the relative ranking of prey to alternate depending upon season, with no one species remaining a superior source of lipid or energy content. Other factors such as gender, location and size had minimal effect on body composition. The relatively large fluctuations in proximate composition have important ramifications for piscivorous predators, which may experience relatively large differences in nutrient content of a single species depending on the time of year they are consumed.

Applied Fisheries Science and Management Issues

<u>**Wednesday 14 January 2004 10:00 AM – 12:20 PM**</u>

Did Bottom Trawling in Bristol Bay's Red King Crab Brood-Stock Refuge Contribute to the Collapse of Alaska's Most Valuable Fishery?
C. Braxton Dew and Robert A. McConnaughey

Producer Cooperatives and Producer Organizations
Ralph Townsend and Gunnar Knapp

Monitoring Dynamics of the Alaska Coastal Current and Development of Applications for Management of Cook Inlet Salmon
T. Mark Willette and W. Scott Pegau

Disentangling the Relative Roles of Subsistence Harvest and Natural Factors in Altering Rocky Intertidal Food Webs and Ecosystem Productivity on the Kenai Peninsula
Anne Salomon, Jennifer Ruesink, Nick Tanape, David Glahn, Paul McCollum and Henry Huntington

The Fishery Interaction Team: Investigating the Potential for Commercial Fishing to Compete with Endangered Steller Sea Lions for Shared Prey
Elizabeth A. Logerwell

Application of New Sonar Technology to Reducing Salmon Bycatch in Pollock Trawl Fisheries
Craig S. Rose

Sperm Whale and Longline Fisheries Interactions in the Eastern Gulf of Alaska
Janice Straley, Victoria O'Connell, Linda Behnken and Sarah Mesnick

POSTERS

Recent Changes in Gulf of Alaska Community Structure
Paul J. Anderson and David R. Jackson-

Trawl Comparisons and Fishing Power Corrections for the *F/V Northwest Explorer*, *R/V TINRO*, and *R/V Kaiyo Maru* During the 2002 BASIS Survey
James Murphy, Olga Temnykh, Tomonori Azumaya, Edward Farley, Jamal Moss and John Helle

Evaluation of Two Methods to Discriminate Pacific Herring (*Clupea pallasi*) Stocks Along the Northern Gulf Of Alaska
Ted Otis and Ron Heintz

Did Bottom Trawling in Bristol Bay's Red King Crab Brood-Stock Refuge Contribute to the Collapse of Alaska's Most Valuable Fishery?

C. Braxton Dew and Robert A. McConnaughey

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The 1976 Magnuson Act effectively eliminated the Bristol Bay no-trawl zone known as the Pot Sanctuary. Implemented by the Japanese in 1959, the boundaries of the Pot-Sanctuary refuge closely matched the well-defined distribution of the red king crab population's mature-female brood stock, thus affording a measure of protection to the reproductive potential of the stock. In 1980, the point at which the commercial harvest of Bristol Bay legal-male red king crab reached an all-time high after a decade-long increase, domestic bottom trawling in the brood-stock sanctuary began in earnest with the advent of a U.S.-Soviet, joint-venture, yellowfin sole fishery. In 1980, the first year of trawling in the Pot Sanctuary, the Bering Sea/Aleutian Islands (BSAI) red king crab bycatch increased by 371% over the 1977-79 average; in 1981 the BSAI bycatch increased another 235%. As the number of unmonitored domestic trawls in the brood-stock area increased rapidly after 1979 and anecdotal reports of "red bags" (trawl cod-ends plugged with red king crab) began to circulate, the proportion of males in the mature population (0.25 in 1981 and 0.16 in 1982) jumped to 0.54 in 1985 and 0.65 in 1986. It is unlikely that normal demographics caused this sudden reversal in sex ratio. Our hypothesis is that alternating, sex-specific sources of fishing mortality were at work. Initially there were ten years (1970-1980) of increasing, male-only exploitation, followed by a drastic reduction in the male harvest after 1980 (to zero in 1983). Then, beginning around 1980, there was an increase in bottom trawling among the highly aggregated, sexually mature female brood stock concentrated within the Unimak-Amak area at the western end of the Alaska Peninsula, an area documented by previous investigators to be the most productive spawning, incubating, and hatching ground for Bristol Bay red king crab. There has been considerable discussion about possible natural causes (e. g., meteorological regime shifts, increasing rates of predation, epizootic diseases) of the abrupt collapse of the Bristol Bay red king crab population in the early 1980s. Our discussion focuses on the association between the overharvest of male crab in the directed fishery, the onset of large-scale commercial trawling within the population's primary reproductive refuge, and the population's collapse.

Applied Fisheries Science and Management Issues

Producer Cooperatives and Producer Organizations

Ralph Townsend[1] and Gunnar Knapp[2]

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In June 2003 the University of Alaska Anchorage Institute of Social and Economic Research (ISER) hosted a workshop on fisheries self-governance. Funding for the workshop was provided by the Pollock Conservation Cooperative Research Center and the University of Alaska.

"Fisheries self-governance" refers to formal and informal arrangements under which groups of fish harvesters are creating organizations and writing contracts to govern themselves, with and without formal recognition by government management agencies. These include cooperatives, formal contractual agreements, industry-only management committees, and (in some cases) informal agreements. Workshop participants from universities, governments, and industry discussed examples of fisheries self-governance in a number of fisheries around the world, including Bering Sea pollock, Alaska weathervane scallop, Chignik salmon, Oregon whiting, New Zealand orange roughy, New Zealand scallop, New Zealand lobster, Atlantic Canada offshore scallops, British Columbia geoducks, Matjes herring, Oregon Yaquina Bay herring, and Hawaii lobsters.

Virtually all forms of fisheries self-governance arose within some kind of limited entry/property rights management program. Self-governance usually involves contracting among the limited set of participants, using traditional contract law. Most cases involved relatively small numbers of fishermen, probably because the transactions costs of negotiating and enforcing contracts increase with the number of participants. The advantage that drives self-governance is that the industry can often negotiate rules more efficiently, can negotiate rules that would be difficult for regulatory agencies to reach (and in some cases, as under the U.S. ITQ moratorium, illegal for agencies), and can enforce rules at lower cost. For example, flexible area closures may be very difficult under regulatory structures with complicated notice-and-hearing procedures, but simple for an industry with a few participants.

Fisheries self-governance structures often include rules that have significant environmental benefits. Some of these environmental benefits arise because the industry benefits directly from the more productive environment, as when harvests of small fish are avoided. In other cases, as in avoiding by-catches or incidental takes, the industry is able to avoid more onerous externally imposed rules. Self-governance can provide a flexible alternative to traditional regulatory structures.

The workshop papers are now being edited for future publication as a book. Copies of presentation and other information about the workshop are available at www.iser.uaa.alaska.edu/projects/coops.htm.

Monitoring Dynamics of the Alaska Coastal Current and Development of Applications for Management of Cook Inlet Salmon

T. Mark Willette[1] and W. Scott Pegau[2]

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This project uses a vessel of opportunity to collect physical oceanographic and fisheries data along a transect across lower Cook Inlet from Anchor Point to the Red River delta. Logistical support for the field sampling is provided in part by the Alaska Department of Fish and Game which has chartered a vessel annually to fish along this transect each day during July providing inseason projections of the size of salmon runs returning to the inlet. The project provides an opportunity for long-term monitoring of oceanographic conditions in Cook Inlet as part of these ongoing fisheries surveys. Investigators are analyzing physical oceanographic data collected by the project to improve management of Cook Inlet salmon through improved inseason salmon run projections. Several hypotheses regarding effects of changing oceanographic conditions on salmon migratory behavior will be tested: (1) salmon migration is delayed when fish encounter strong salinity gradients, (2) interannual changes in freshwater outflow from upper Cook Inlet or the northward extent of the Alaska Coastal Current affect salmon migratory timing, (3) the variance of relative salmon density is a function of salmon abundance and the structure of tide rips, and (4) salmon use tidal currents in upper Cook Inlet to facilitate their northward migration. The oceanographic data collected by the project will also provide for valuable validation of remote sensing products, improved understanding of ocean dynamics in lower Cook Inlet, and a highly powerful statistical evaluation of oil spill risk analysis models.

Applied Fisheries Science and Management Issues

Disentangling the Relative Roles of Subsistence Harvest and Natural Factors in Altering Rocky Intertidal Food Webs and Ecosystem Productivity on the Kenai Peninsula

Anne Salomon[1], Jennifer Ruesink[1], Nick Tanape[2], David Glahn[3], Paul McCollum[4] and Henry Huntington[5]

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The removal of a strongly interacting species by fishing can fundamentally alter coastal food web structure and function. Although current fisheries science is increasingly recognizing the ecosystem-level effects of fishing, the mechanisms involved remain elusive in part because systems are large, effort is widespread, natural forcing functions are prevalent and manipulations of effort at the appropriate scale are not always tractable. On the rocky shores of the outer Kenai Peninsula the black chiton, *Katharina tunicata*, known locally as 'Bidarki', remains an important traditional subsistence food source for Sugpiaq Natives. Elsewhere, this strongly-interacting benthic grazer is known to have dramatic impacts on the community structure, dynamics and productivity of temperate rocky intertidal food webs. We evaluated the relative roles of *Katharina* harvest versus natural factors (predation by sea otters, variable recruitment and wave force) in altering the density and size structure of *Katharina*. Furthermore, we quantified the direct and indirect effects of exploitation on the composition and productivity of this coastal marine food web. Large *Katharina* (> 70 mm) become increasingly rare at sites that are more frequently visited for traditional subsistence harvest, however sea otter presence is greater and recruitment is lower at these sites thereby synergistically contributing to lower densities of the chiton. Primary production (kelp growth) and algal and invertebrate assemblages vary among heavily, moderately and unharvested sites. Our comparisons of community structure and productivity across sites cannot resolve causation because of covariance among the factors that could influence community structure (i.e. high human harvest and sea otter predation, low recruitment, reduced wave exposure). However, experimental removals of *Katharina*, now in process, will help determine its interaction strength. Two large-scale adaptive management harvest experiments plus a series of small-scale removal experiments across sites of varying levels of wave exposures and predation will allow us to elucidate and predict the indirect, food web effects of subsistence harvest and/or natural factors that reduce *Katharina* densities. Finally, demographic parameters of *Katharina* at both harvested and unharvested sites will provide information to facilitate the sustainable harvest and conservation of this ecologically and culturally important species.

The Fishery Interaction Team: Investigating the Potential for Commercial Fishing to Compete with Endangered Steller Sea Lions for Shared Prey

Elizabeth A. Logerwell

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The Fishery Interaction Team (FIT) at the Alaska Fisheries Science Center (National Marine Fisheries Service, USA) was formed in 2000 to investigate the potential impact of commercial fishing on the spatial distribution and abundance of marine fishes. FIT researchers are presently interested in interactions between commercial fisheries and endangered Steller sea lions. Specifically, we are conducting experiments to determine whether commercial fishing operations potentially impact the foraging success of sea lions either through disturbance of prey schools or through direct competition for a common prey. The objectives of our current research projects are to: 1) test the hypothesis that commercial fishing results in depletion or disruption of prey fields at the spatial scale of tens of nautical miles and the temporal scale of weeks, and 2) evaluate the efficacy of management measures designed to mitigate competition between commercial fishing and sea lions. This presentation will provide a brief overview of our three field investigations and summarize results to date. Particular attention will be paid to the results of our research on the efficacy of trawl exclusion zones in the Aleutian Islands. Trawl exclusion zones were put into place around several sea lion rookeries in response to concerns about localized depletion of Atka mackerel, the primary prey of sea lions in the Aleutians. In order for the zones to be effective at maintaining sufficient prey for Steller sea lions there should be little movement of fish from inside to outside the zones and the abundance of fish within the zones should be high. Results to date suggest that in some areas there is little fish movement from inside to outside the exclusion zones and fish abundance inside is high. In other areas, the opposite appears to be true – fish movement is high and abundance inside exclusion zones is low. These differences may be due to differences in the size and location of trawl exclusion zones between areas. The implications of these results for the design of protective measures such as trawl exclusion zones and marine protected areas will be discussed.

Application of New Sonar Technology to Reducing Salmon Bycatch in Pollock Trawl Fisheries

Craig S. Rose

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Trawl modifications to reduce salmon (*Oncorhynchus* sp.) bycatch in Alaska's walleye pollock (*Theragra chalcogramma*) fisheries are being jointly developed by the fishing industry and scientists from the Alaska Fisheries Science Center. Critical to this effort is the ability to observe the response of both species to trawl components during capture without artificial light. The necessary capability has been provided by development of a high-resolution, rapid-update sonar. Initial observations with this sonar indicated that salmon used their superior swimming ability to move back and forth in the trawl, while pollock were limited to very brief forward movements. Design concepts to exploit this difference to allow salmon escape were provided through consultation with trawl skippers and builders. Specific designs were developed and tested, first in a flume tank and then in the field. Sonar and video observations confirmed salmon and pollock reactions to several device configurations and a single design was selected for performance testing. Tests under commercial conditions, using a recapture net to retain escaping fish, estimated that 12% of the salmon were able to escape, while 98% of the pollock were retained. Behavior observations during those tests indicated several options for improving species separation. Further tests will be conducted beginning in January 2004.

Sperm Whale and Longline Fisheries Interactions in the Eastern Gulf of Alaska

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Sperm whales have learned to take sablefish, a natural prey, off longline gear in the Gulf of Alaska. Reports of depredation were first noted in 1978 and have steadily increased in frequency and severity, with a notable increase since the late 1990s, likely due to the lengthening of the fishing season. No mortality or serious injury has yet occurred, although mortalities and serious injury of sperm whales have occurred in other areas of the world due to similar fisheries interactions. In Alaska, depredation has created economic loss for fishermen and presents fisheries managers with a difficult assessment problem because the amount of sablefish mortality caused by sperm whales is unknown. Through cooperative research with fishermen, government and scientists, our ultimate goal is to provide recommendations for strategies to reduce or eliminate depredation on longline gear by sperm whales.

During the first year of this study, we collected information, with collaboration from ten fishermen from the southeastern Alaskan fishing fleet, about interactions with sperm whales, including the timing of interactions seasonally and diurnally. We collected photographs of 17 individual sperm whales occurring near longline vessels, and at least that many were involved in depredation, on sablefish and halibut between March and August 2003. Three whales were resighted twice and one whale was resighted four times. Ten genetic samples were taken from a total of six different whales; all of which were male. We found that sperm whales were vocally active around longline vessels deploying and hauling in gear, making short pulses called 'clicks' that are generally believed to allow the whales to navigate, detect, and forage on individual prey items—in this case, hooked fish. Future plans include adding a passive acoustic component to track whales, longline gear and longline vessels simultaneously and obtain acoustic profiles of each vessel. We hope, eventually, this research will: define the scope of the problem; help identify stock structure and the ecology of this endangered species; provide baseline information needed for studying depredation mechanisms and cues; and, finally, develop solutions to reduce negative interactions.

POSTER: Applied Fisheries Science and Management Issues

Recent Changes in Gulf of Alaska Community Structure

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Significant changes in community structure of the benthic and epi-benthic community have been observed in the area adjacent to Kodiak Island area since 1998. Recent results from the ongoing long-term small-mesh trawl survey which has been conducted in the Gulf of Alaska for more than 50 years (1953 -2003) indicates partial community structuring is taking place in the Kodiak Island region. In general, shrimp and forage fishes are increasing and some, but not all, predatory fishes are declining or shifting their distribution. Several species of Pandalid shrimps have increased in overall abundance in some Kodiak Island and adjacent Alaska peninsula bays. Analysis of size structure of the pandalid shrimp population gives some clues to the age of relatively dominant year classes. It appears that most of the biomass is the result of the formation of strong year-classes since 1998. This coincides well with observations of the PDO index that indicate cooler ocean conditions in the northeast Pacific Ocean since 1998. It appears that pandalid shrimp are good indicators of changing ocean conditions. There has also been an observed increase in the overall abundance of eulachon (especially of young of the year size classes) in most sampled areas. Less spatial segregation in eulachon abundance is apparent in recent survey data when compared to other increasing species groups. While some surveyed locations show significant community composition changes, other areas remain virtually unchanged from earlier recent surveys. Spatial segregation of community composition trends needs to be studied in order to understand driving mechanisms that may be controlling these changes.

Trawl Comparisons and Fishing Power Corrections for the *F/V Northwest Explorer*, *R/V TINRO*, and *R/V Kaiyo Maru* During the 2002 BASIS Survey

James Murphy[1], Olga Temnykh[2], Tomonori Azumaya[3], Edward Farley[1], Jamal Moss[1], and John Helle[1]

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Multi-vessel surveys are an integral component of the BASIS (Bering-Aleutian Salmon International Survey) research program, requiring the standardization of catch rates between vessels. Fishing power models were developed for this purpose using data from a joint trawling experiment in the Bering Sea between September 12 and September 18, 2002. The *Kaiyo maru* (Japan) and the *Northwest Explorer* (United States) completed joint trawling at five stations, the *Northwest Explorer* and the *TINRO* (Russia) completed joint trawling at six stations, and all three vessels completed joint trawling at one station. Trawls differed in their headrope length and number of wingtips; trawls were configured with different bridle lengths, warp lengths, door sizes, and footrope weights; and vessels differed in their size and horsepower. These differences resulted in differences in sampling depth (vertical opening of the trawl), trawl width, warp length, and trawling speed. Immature chum salmon (*Oncorhynchus keta*), sockeye salmon (*O. nerka*), chinook salmon (*O. tshawytscha*), and juvenile Atka mackerel (*Pleurogrammus monopterygius*) were the primary species and life-history stages caught during the trawl comparisons; models were constructed for each of these species. Generalized linear models were used to fit fishing power models to catch and catch rates with a robust maximum likelihood approach. Results from fishing power models indicate that the *Kaiyo maru* had the greatest fishing power for both catch and catch rates for all species, followed by the *TINRO* and the *Northwest Explorer*. The *TINRO* and the *Northwest Explorer* were most similar in their fishing power for salmon, whereas the *Kaiyo maru* and *TINRO* were most similar in their fishing power for Atka mackerel. Fishing power corrections were larger for catch than catch rates due to different effort levels by each vessel. Catch rate fishing power coefficients for all species were significant at the $p<0.10$ level; however, only Atka mackerel was significant at the $p<0.05$ level. Fishing power coefficients for catch for all species except sockeye salmon were significant at the $p<0.10$ level; Atka mackerel and chinook salmon were significant at the $p<0.05$ level. Fishing power models were able to provide reasonable corrections for the different pelagic trawls used by BASIS vessels, and will enable us to jointly analyze catches from all three vessels.

Evaluation of Two Methods to Discriminate Pacific Herring (*Clupea pallasi*) Stocks Along the Northern Gulf Of Alaska

Ted Otis[1] and Ron Heintz[2]

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Understanding the stock structure of northern Gulf of Alaska (NGA) herring is relevant to how these exploited populations are assessed and managed. We evaluated the capabilities of otolith microchemistry and heart tissue fatty acid profile to identify the stock of origin for herring sampled from four focal spawning aggregations in the NGA, and two outside the NGA (Sitka and Togiak). Otolith microchemistries were measured (ppt) using an electron microprobe equipped with four wavelength dispersive spectrometers. Fatty acid profiles were identified by gas chromatography and flame ionization of lipids purified from whole hearts. MANOVA revealed significant differences in the otolith microchemistries of herring from the three regions: Sitka, Togiak and (P<0.0001). However, discriminant function analysis (DFA) indicated that otolith microchemistries could not be used to discriminate herring from the NGA from those of the other regions. Similarly, differences were detected among the four focal spawning aggregations sampled in the NGA, but these could not be reliably discriminated into *a priori* groups. Analysis of the fatty acid data revealed significant regional differences among the herring from Sitka, NGA and Togiak (P < 0.0001) and also among the four NGA stocks (P < 0.0001). The DFA demonstrated that fatty acid profiles could be used to correctly identify unknown samples from the four NGA groups more than 90% of the time. These data demonstrate the potential for using heart tissue fatty acid profiles to discriminate among Pacific herring stocks on relatively fine spatial (< 100 km) scales.

Undersea Research and Ocean Exploration

Wednesday 14 January 2004 1:30 – 2:50 PM

Research on Benthic Habitat at the NOAA Fisheries Auke Bay Laboratory
Jonathan Heifetz, Robert P. Stone, Patrick W. Malecha, Dean L. Courtney, Jeffrey T. Fujioka, and Phillip W. Rigby

Biological Exploration of Canada Basin
Katrin Iken, Bodil Bluhm, Rolf Gradinger, Russ Hopcroft, Terry Whitledge, Ian McDonald, Mike Vecchione, David Stein

Effects of Chronic Bottom Trawling on the Size-Structure of Soft-Bottom Benthic Invertebrates in Bristol Bay
Robert A. McConnaughey, Stephen E. Syrjala and C. Braxton Dew

Pilot Nearshore Habitat Mapping Using Acoustic and Visual Techniques in Bristol Bay, Alaska
Brian D. Bornhold, John R. Harper, and Kel Kopeck

POSTERS

NaGISA: Natural Geography In Shore Areas
Katrin Iken and Brenda Konar

Multibeam Sonar Mapping of Deep Coral Habitat in the Central Aleutians
Jennifer R. Reynolds, Jonathan Heifetz, Douglas A. Woodby, Robert Stone, Tracy L. Vallier and H. Gary Greene

Research on Benthic Habitat at the NOAA Fisheries Auke Bay Laboratory

Jonathan Heifetz, Robert P. Stone, Patrick W. Malecha, Dean L. Courtney, Jeffrey T. Fujioka, and Phillip W. Rigby

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Since 1996, the Auke Bay Laboratory has been conducting research on the effects of fishing gear on benthic habitat. Most of this research has focused on the effects of bottom trawls because this gear is the most controversial due to documented changes in species composition and diversity and a reduction in habitat complexity associated with use of this gear type. This research has been in response to the need for information to develop appropriate measures for minimizing the adverse impacts of fishing on habitat, as required in the Magnuson-Stevens Fisheries Management Act. Research has focused on 1) understanding the direct effects of bottom trawling on seafloor habitat; 2) the associations of fish and invertebrate species with habitat features that may be affected by fishing gear; 3) development of analytical tools to assess habitat impacts and evaluate proposed mitigation measures; and 4) life histories of habitat-forming benthic invertebrates. The purpose of this talk is to provide an overview of research on benthic habitat being conducted by the Groundfish Assessment Program at the Auke Bay Laboratory. Highlighted is new research that focuses on coral and sponge habitat in the Aleutian Islands. This research will provide the first detailed mapping of coral and sponge habitats for the Aleutian Islands, where species diversity is unusually high and where incidental mortality of corals and sponges is a challenging problem in the area's fisheries that use bottom contact gear. The goal of this multidisciplinary research is to construct a statistical model to predict coral and sponge distribution as a function of measurable environmental characteristics, and if successful, this predictive model can be used to inform management decisions for protecting corals and sponges in areas lacking detailed mapping and dive-supported observations.

Biological Exploration of Canada Basin

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In August 2002, the NOAA Ocean Exploration Program funded a multidisciplinary cruise to the deep Arctic Canada Basin. Focal points of the biological studies were water column productivity, sea ice communities, zooplankton and nekton communities, benthic communities and the interconnecting trophic web structure. Imaging tools, such as the ROV "Global Explorer" or video recordings under the sea ice proved to be powerful tools in giving first impressions of this under-explored high Arctic ecosystem.

Carbon and nitrogen productivity of the water column was measured at 13 locations including three ice stations. A chlorophyll maximum was observed at many stations at 50-60 m. Primary production under the ice is about an order of magnitude lower than in open water. The occurrence and behavior of sympagic amphipods and Arctic cod were studied. Amphipods were less abundant than reported from other parts of the Arctic, but occurred in mean abundances between 1 and 23 m^{-2} at each station. Small schools of Arctic cod were discovered in narrow wedges along the ice edges, which were documented for the first time as important fish habitat. An unexpected high abundance of small-bodied copepod species was found, the importance of which has not been pursued in the Arctic. *In situ* observations suggested a more abundant assemblage of gelatinous taxa than expected, with many species having distinct depth ranges, some extending to the bottom of the basin. Macro-infauna was sampled by box core between 640-3250m. Total abundances and biomass were highest in the shallow Amundsen Gulf and lowest in the deep basin. Polychaetes and crustaceans were most abundant while polychaetes and mollusks dominated the biomass. ROV surveys revealed epifauna where hard substrate was available for attachment. Species diversity of fishes was low with only six putative species; diversity varied among stations sampled. Qualitative ROV video analysis suggests that demersal nekton may be selecting habitats based on the presence or absence, or density, of other benthic forms. Stable isotope analysis suggests that most of the primary production is consumed by water column grazers and that the benthos relies more on refractory material received from sinking grazers and their products.

Effects of Chronic Bottom Trawling on the Size-Structure of Soft-Bottom Benthic Invertebrates in Bristol Bay

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Although chronic bottom trawling reduces benthic biomass, it is generally unknown whether this represents a decrease in numbers of individuals or a decrease in mean body size. This distinction is important because body size directly affects the fitness of individuals, thereby influencing the structure and function of populations, communities and ecosystems. Using comprehensive historical effort data, adjacent untrawled (UT) and heavily trawled (HT) areas were identified along the boundary of a long-standing no-trawl zone in Bristol Bay, a naturally disturbed offshore area of the eastern Bering Sea. The study site is shallow (44-52 m) with a sandy substrate, ubiquitous bottom ripples, and strong tidal currents. A modified research trawl was used to collect 42 HT-UT paired samples of benthic epifauna and infauna. These data were used to compare mean sizes (kg) of 16 invertebrate taxa. On average, fifteen of these taxa were smaller in the HT area and the overall HT-UT difference in body size was statistically significant (P=0.0001). However, only the whelk *Neptunea* (P=0.0001) and the Actiniaria (sea anemones; P=0.002) were significantly smaller in the HT area after correcting for multiple tests. Mean size of red king crab was 23% *greater* in the HT area (P=0.17). Supplemental length-frequency data indicate that substantially fewer small red king crab, rather than more large individuals, occupy the HT area (P=0.0001). We consider these results in combination with biomass differences reported previously and draw general conclusions about the status of these populations. Overall, the observed effects are generally consistent with theoretical expectations but were probably limited in magnitude by site-specific factors. Finally, a large number of within-year, within-taxon comparisons of mean body size was made using 1982-2001 NMFS trawl survey data collected in the same closed area. These comparisons indicate natural variability of body size in untrawled areas is large relative to the observed HT-UT differences due to chronic bottom trawling. Unfortunately, our ability to interpret the observed effects is limited because so little is known about the invertebrate taxa studied, not to mention the complex linkages amongst them and with federally managed groundfish.

Pilot Nearshore Habitat Mapping Using Acoustic and Visual Techniques in Bristol Bay, Alaska

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A pilot field program was undertaken in northern Bristol Bay to assess the utility of using a combination of acoustic (sidescan sonar) and visual (seabed video) techniques for nearshore habitat mapping and monitoring. Three sites were selected in coastal embayments: western Ungalikthluk Bay, northeastern Summit Island and western Metervik Bay. Sites were surveyed from the intertidal zone to maximum water depths of about 15 m.

This pilot project has demonstrated the efficacy of using a combination of sidescan sonar and towed seabed video imagery for habitat delineation in nearshore areas. Sidescan sonar provides complete seafloor acoustic coverage for mapping substrate types. Ground-truth for substrate interpretations and biological data are provided by video imagery collected with the Seabed Imaging and Mapping System (SIMS, a towed video system). High-frequency (390 kHz) sidescan sonar can be used to map eelgrass distributions. The study showed that sufficient precision exists to use sidescan, ground-truthed by visual data, for monitoring longer-term changes in the distribution of eelgrass.

The combination of geological data with biological data from towed video allowed habitat associations to be delineated. The following common associations were identified by the dominant floral components in Ungalikthluk and Metervik Bays: (1) Eelgrass – sandy gravel, (2) Bladed kelps - sandy gravels (with filamentous red algae), (3) Foliose red algae – muddy-sandy gravel and (4) Coralline algae – bouldery/cobbly sandy gravel (with green urchins and bryozoans).

The videography classification was evaluated for monitoring potential. Assessments of errors associated with video mapping revealed: positional errors of ±4m (95% confidence), no significant intra-classifier error (one mapper classifying replicate images) but some differences of inter-classifier error (two mappers classifying the same imagery). Classifier error was resource-dependent (e.g., some species are more easily classified than others). Sensitivity analysis of eelgrass mapping data suggests that the technique is robust enough to detect quite small changes in eelgrass covers; cover changes of less than 10% can be detected under most conditions.

NaGISA: Natural Geography In Shore Areas

Katrin Iken and Brenda Konar

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The potential loss of marine biodiversity has recently spurred an increasing number of studies to identify the importance of biodiversity for ecosystem functioning. Coastal marine biodiversity has the potential to be high when the three-dimensional structure of macroalgal habitats and seagrass communities is present. These shallow water coastal areas also are the areas most impacted by humans, resulting in potential severe effects on near-shore biodiversity. Within the last decade, the need for nearshore biodiversity studies on a large spatial or even global scale has become increasingly obvious. Comparative studies are often hampered by the use of varying methods. For a comparative biodiversity assessment of various spatial and temporal scales, a unified approach is needed.

NaGISA is the Initial Field Project for the Census of Marine Life (CoML) established to examine nearshore biodiversity in macroalgal and seagrass communities on a global scale. The overall goal of this project is to sample globally using protocols developed by the Census of Marine Life program. The NaGISA standard protocols are used to select large core areas and replicate sample sites within the core areas. Standard protocols also are used for sampling. There are two levels of sampling with increasing difficulty. Non-destructive sampling involves the use of photography and observational techniques within random quadrats. Destructive sampling involves the clearing of macrophytes, small macrobenthos and meiobenthos within random quadrats. All flora and fauna are sorted and quantified. Various diversity indices are applied and voucher specimens are made. All data are stored in an international database.

In Alaska, NaGISA sampled in the summer of 2003 with the assistance of local communities, kids groups and university classes. Within each of the larger core areas of Prince William Sound, Kodiak Island, and Kachemak Bay, three rocky bottom sites and one seagrass site were sampled. Over 550 samples are currently being sorted and the first subset of organisms has been sent to taxonomists for verification. A second year of sampling will occur next summer at these same sites to determine annual variation.

POSTER: Undersea Research and Ocean Exploration

Multibeam Sonar Mapping of Deep Coral Habitat in the Central Aleutians

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Recent concern about the role of deep coral species in marine ecosystems, and questions about their vulnerability to disturbance by fishing gear, have prompted an investigation of the distribution of deep coral in the central Aleutian region of Alaska. Recovery of corals by trawl surveys and bycatch in fishing gear indicates that the Aleutians, home to major fisheries, may harbor the highest abundance and diversity of temperate water corals in the world [Heifetz, 2002]. We have initiated a multidisciplinary study to identify habitat associations of the coral and sponge species, with the goal of constructing a predictive model for the distribution of these species on a regional scale. The Aleutian Island chain extends 1600 km westward from the Alaskan mainland; our study focuses on the 500 km central section between Seguam Pass (174 W longitude) and Petrel Bank (180 W longitude). The study combines seafloor characterization by multibeam sonar mapping and supplementary geological information, with visual observations and sampling using the manned submersible Delta (2002-2004) and remotely operated vehicle Jason II (in 2004).

The Aleutian Islands rest on a submerged shallow platform, the Aleutian Ridge, which forms the boundary between the Pacific Ocean and the Bering Sea. The two flanks of the ridge thus face different water masses and current regimes. The seafloor texture and morphology are controlled by local geology. General seafloor categories include slopes mantled by young volcanic debris from the Aleutian arc volcanoes; the shallow, current-swept platform with extensive bedrock outcrops; sediment-covered slopes with sand and mud waves, gullies, and slumps; and deep canyons that cut layers of marine and volcanic sedimentary rock. Fishing pressure varies across the region for both ecological and regulatory reasons. In June 2003, we conducted multibeam bathymetry and backscatter surveys of 17 representative sites, using a combination of 100 kHz and 24 kHz sonar systems. This presentation will focus on the results of the multibeam mapping, with examples of dive observations from the manned submersible Delta. Additional resources: http://www.afsc.noaa.gov/abl/MarFish/coral.htm

Ecosystem Modeling and Data Transfer

Wednesday 14 January 2004 3:10 – 4:30 PM

Comparative Analysis of Statistical Tools to Identify Recruitment-Environment Relationships and Forecast Recruitment Strength
Bernard A. Megrey, Yong-Woo Lee and S. Allen Macklin

Responses of Ichthyoplankton Biodiversity and Dynamics to Environmental Change
Wiebke J. Boeing, Janet T. Duffy-Anderson and Kevin M. Bailey

Detecting Change in the Bering Sea Ecosystem
Sergei Rodionov, James E. Overland and Nicholas A. Bond

Predicting State-Dependent Foraging and its Ecological Consequences: Harbor Seals Amidst Predators in Prince William Sound
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POSTERS

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Mary C. Morris, Susan M. Saupe and Mandy R. Lindeberg

Comparative Analysis of Statistical Tools to Identify Recruitment-Environment Relationships and Forecast Recruitment Strength

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The collective impacts of regime shifts, large multidecadal-scale forcings of marine ecosystems (such as those attributed to the PDO), and natural and man-made influences on variability in fish populations and future states of ecosystems are widely recognized as important areas of study. However, the complexity of the problem often seems beyond the capabilities of traditional statistical analysis paradigms. There may be limitations in theoretical development, inadequate length of time series, the need to partition already short time series into segments representing identified regimes, lack of degrees of freedom, or the inability to meet required assumptions.

This study examines the utility of five separate statistical procedures to identify relationships between recruitment and the environment. Because we can never really know the parameters or underlying relationships of actual data, we chose to use simulated data with known properties and different levels of measurement error to test and compare the methods, especially their ability to forecast future recruitment states. Methods examined include traditional nonlinear regression, multinominal logistic regression, General Additive Models, Generalized Neural Networks, and Probabilistic Neural Networks. Each are compared in their ability to recover known patterns and parameters from the simulated data, as well as to accurately forecast future recruitment states.

Responses of Ichthyoplankton Biodiversity and Dynamics to Environmental Change

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Consequences of the 1976 climatic regime shift in the North Pacific Ocean on the ecosystem were only recognized at higher trophic levels almost a decade afterwards. Lower trophic levels should be most responsive and reflect changes due to environmental perturbations before they propagate upwards, making them potentially useful as early indicators of ecosystem perturbations. The goal of our study is to create a variety of sensitive indices that could be valuable for assessing ecosystem integrity and predicting ecosystem change by exploring lower trophic level dynamics, especially the ichthyoplankton. We are analyzing over 24 years of ichthyoplankton data from the Gulf of Alaska (collected by the Recruitment Processes Program of the Alaska Fisheries Science Center) to develop new metrics to evaluate ecosystem change. We standardized abundance data for each of 77 ichthyoplankton taxa and clustered them into 18 functional groups with the Bray-Curtis distance measure and Flexible Beta linkage method. Variance Partitioning Analysis stressed the importance of geographical and seasonal processes for ichthyoplankton dynamics. Therefore, we used seven geographical strata within the Gulf of Alaska and focused on the May ichthyoplankton assemblage for further analyses. Response variables (abundance of species and functional groups, survival index, diversity, zooplankton volume) were linked to environmental explanatory variables (pacific decadal oscillation, temperature, freshwater runoff, upwelling, retention and wind indices) by canonical correspondence analysis and a multiple regression model. The ichthyoplankton assemblage seems especially sensitive towards temperature indices and survival and diversity indices are probably more reliable indicators than abundance or biomass alone.

Detecting Change in the Bering Sea Ecosystem

Sergei Rodionov[1], James E. Overland[2] and Nicholas A. Bond[1]

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Regime shifts are rapid reorganizations of a marine ecosystem from one relatively stable state to another. A life span of such regimes may vary from several years to several decades. A number of methods have been developed to detect regime shifts (or discontinuities) in time series. A review of those methods showed that all of them have the same problem, namely, a drastic deterioration of the test statistics toward the ends of time series. Consequently, a substantial amount of data (at least 5-10 years) must be collected before a regime shift can be detected. As a result, those methods are not suitable for a real-time detection and monitoring of regime shifts. In attempt to overcome this problem, a new method utilizing some ideas of a sequential analysis has been developed. The SARS (Sequential Analysis of Regime Shifts) method works as follows. When a new observation arrives, SARS checks whether it represents a statistically significant deviation from the mean value of the previous regime. If it does, this year is marked as a potential shift, and subsequent observations are used to confirm or reject this hypothesis. An index characterizing the magnitude of the shift (a cumulative sum of the normalized anomalies relatively to the new level) is calculated for each year after the regime shift. The value of the index is compared with its historical values to determine the probability with which the index can reach the level characteristic of major regime shifts. The SARS method is applied to the Bering Sea ecosystem. The ecosystem is characterized by 44 indices broken into five categories: climate indices, atmosphere, ocean, fishery, and biology. All these indices are available from the Bering Climate web site (www.BeringClimate.noaa.gov). Special attention is paid to the ecosystem changes occurring around 1989 and in recent years. In an overall sense, the state of the Bering Sea ecosystem has not undergone a major change since the regime shift of 1976/77.

Predicting State-Dependent Foraging and its Ecological Consequences: Harbor Seals Amidst Predators in Prince William Sound

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We present a dynamic state variable model of foraging decisions by harbour seals (*Phoca vitulina*) exposed to predation risk from sleeper sharks (*Somniosus pacificus*) and transient killer whales (*Orcinus orca*). The focus is on adult female seals trying to maximise reproduction by surviving to the pupping season with as high level of energy reserves as possible. A threshold level of energy reserves is required for reproduction, and increments above this level yield higher offspring survival. The model system is Prince William Sound, Alaska, where killer whale predation is common and harbour seals have been declining over the last two decades. During this period, sleeper sharks appear to have become more abundant and the structure of the forage fish community has changed. Thus, we seek insights into:

- How interactions between food distribution and risk from multiple predators might influence seal behaviour, energy gain, and fitness.
- The effects of internal state (energy accumulated, oxygen level, time remaining to reproduction) on risk taking and predation rates experienced by the seals.
- How sharks and transient killer whales might indirectly affect fish populations by reducing both the per capita foraging rates and density of seals.

POSTER: Ecosystems Modeling and Data Transfer

North Pacific Ecosystem Theme Page and Metadatabase

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The North Pacific Ocean Theme Page (NPOTP) and the North Pacific Ecosystem Metadatabase (NPEM) are one-stop resources for researchers, managers, educators, and administrators addressing North Pacific marine science topics. The theme page is a forum for accessing, presenting and discussing historical information, and for exploring new ideas, plans and research results. The metadatabase is a dynamic catalog of environmental information (including listings from NPRB, EVOSTC, Steller Sea Lion Research Program, FOCI, etc.) and is made available to users through the Internet. Together the NPOTP and the NPEM provide synergy among data producers, data archivists, and data users by making available to people with varying backgrounds and intents the information they need to produce the building blocks from which societal advances are made.

POSTER: Ecosystems Modeling and Data Transfer

A *ShoreZone Mapping Protocol* for Use in Mapping Regional Variations of Nearshore Habitat along the Gulf of Alaska Coast

John Harper[1], Susan Saupe[2] and Mary Morris[3]

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A rapid survey and mapping technique involving the use of oblique aerial video imagery has been used to map resources on over 5,000 km of shoreline in the Gulf of Alaska during 2001, 2002 and 2003. Geomorphic and biotic categorization of coastal habitat uses the *Alaska ShoreZone Mapping Protocol*, which is based on the ShoreZone system that is widely used throughout the Pacific Northwest (approximately 40,000 km of shoreline mapped in Washington and British Columbia). There are several unique aspects of the mapping system: (a) digital imagery has been web-posted allowing public access of the low-tide imagery, (b) exposure levels are determined from biotic assemblages within each shore unit, (c) regional distributions in biotic communities, including wetlands, red algae, brown algae, eelgrass, and kelps, are mapped and (d) man-made disturbances are characterized. Detailed definitions and descriptions of intertidal classifications are provided by coordinated on-the-ground surveys. The hierarchical nature of the classification makes it a powerful habitat management tool, and data have been used in spill response planning, research, essential fish habitat documentation, stewardship programs and regional land-use planning. Example queries of data from the northern Gulf of Alaska, show that wetlands occur along ~20% and eelgrass along 7% of those shorelines and geographical differences in the distributions of kelp.

The protocol (Harper and Morris 2003) specifies a set of standards for intertidal and nearshore mapping so that (a) users have a clear understanding of the assumptions and methods incorporated into the mapping data and (b) future mappers have guidelines to ensure mapping consistency among agencies and mappers.

Oil Spill Modeling With and Without Sea Ice Cover in the Beaufort Sea

Meibing Jin[1] and Jia Wang[2]

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Using station wind data and simulated surface current, sea ice velocity and ice concentration from a coupled ice-ocean model, we conducted a series of simulations of oil spill released in different time with and without sea ice cover. The results show significant seasonal and interannual variability of the oil spill trajectory under simulated ice conditions. Sea ice cover can affect oil spill trajectory by reducing wind effects on sea surface current, sea ice flow and oil spill velocity. Ice flows dominate the oil spill movement in the winter months, and wind has larger effects on oil spill movement during the summer.

POSTER: Ecosystems Modeling and Data Transfer

ShoreZone Mapping in the Gulf of Alaska: Linking Intertidal Species Assemblages from Ground Surveys to Regional Mapping

Mary C. Morris[1], Susan M. Saupe[2] and Mandy R. Lindeberg[3]

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Using an innovative database design, on-the-ground observations of intertidal biophysical characteristics from over 50 shore stations in south central Alaska are used to define and describe characteristics mapped during an aerial mapping program conducted in the same area. These descriptions provide the 'bottom-up' link to the definitions of intertidal attributes used during the ShoreZone biophysical mapping project underway along northern Gulf of Alaska coastlines. The ShoreZone mapping project uses low-tide aerial video imagery to classify and map intertidal geomorphology and biota across wider geographic ranges. The ground station database is spatially linked to over 4,500 along-shore mapping units, including estuaries and exposed rocky coasts from Cook Inlet to Port Bainbridge in Prince William Sound.

The shore station database was used to determine the species composition and geomorphic characteristics of features identified during the aerial classification. Illustrated descriptions of 17 'biobands' (characteristic species assemblages visible in aerial imagery) and 11 'habitat classes' (summary categories of intertidal biophysical characteristics) were defined. The database will provide user-friendly definitions of the habitats and species assemblages, as well as links to information about dominant individual species and type locations.

OSRI

TWO-YEAR REPORT

2001 - 2002

Prince William Sound
Oil Spill Recovery Institute

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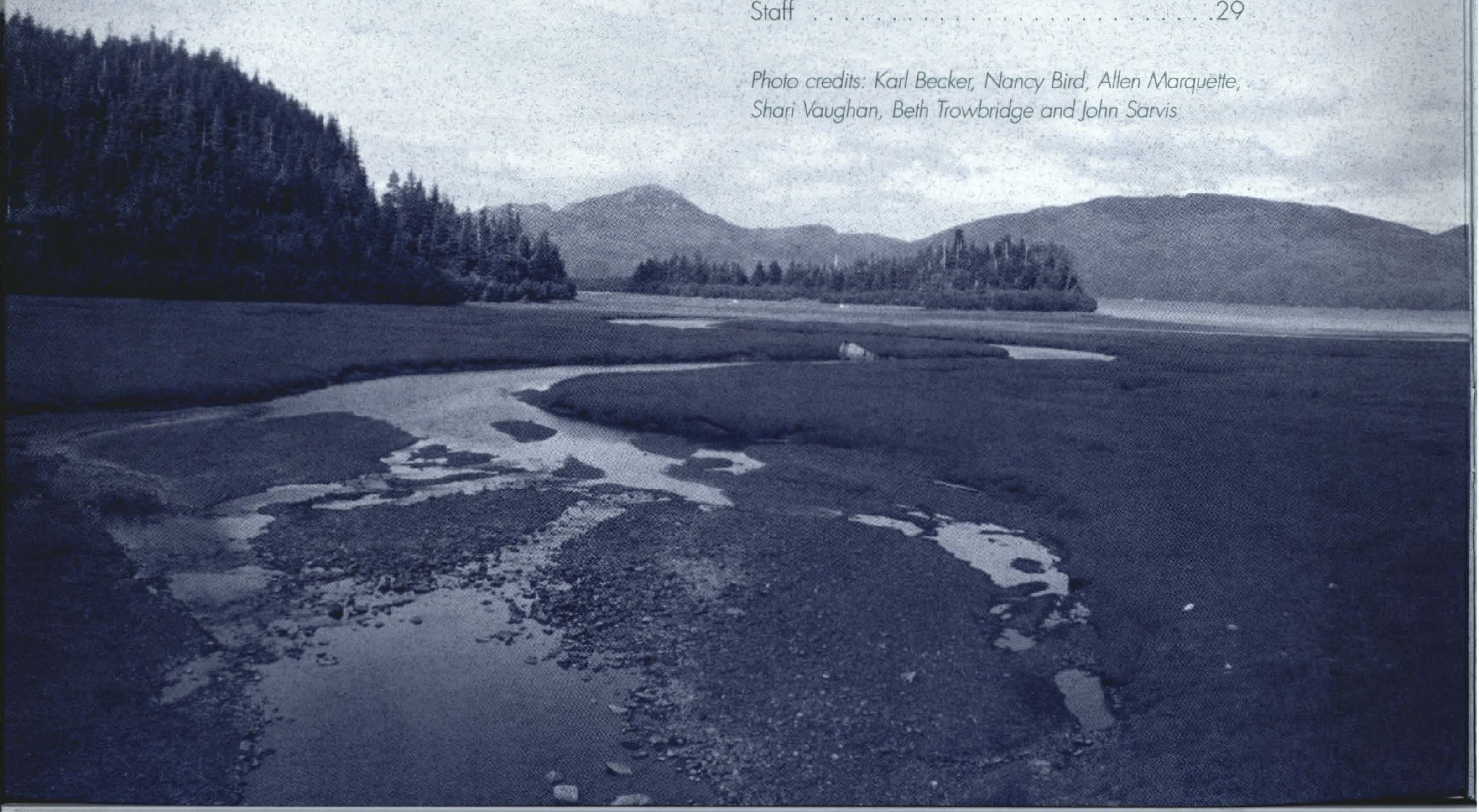

July 22, 2003

The OSRI research program was extremely busy during 2001 and 2002 with a broad variety of technology, ecology and education projects funded, summaries of which are found in this report. Grant awards reached their highest level in 2001, both in overall number of projects funded, 29, and in annual spending of just over $1.5 million. In contrast, average annual spending between the fiscal years 1998 and 2002 was $1 million.

A major premise underlying OSRI's programs is the need to understand the interconnectedness of the marine ecosystems and how biological patterns are controlled. It is this kind of knowledge that was missing after the 1989 Exxon Valdez oil spill. As stated in a recent National Research Council report prepared for OSRI, "Without this fundamental knowledge, predictions, prevention, response, remediation and resource damage assessment can be in jeopardy of being ineffective or inaccurate and thus potentially wasting financial resources and putting natural resources at risk."

The Nowcast Forecast System (NFS) for Prince William Sound, developed primarily by OSRI since 1999, has made good progress toward gaining that fundamental knowledge. NFS today includes three modeling components that can provide nowcasts, forecasts and hindcasts on the oceanographic currents, the atmospheric conditions and oil spill trajectory and chemical fates and effects in the Prince William Sound region. This information recently became available to the public through a web site called the Prince William Sound Ocean Observing System, www.pwsoos.org. In the next few years, the NFS will add a biological model focused on Pacific herring and work will continue to further verify the models and make more information available to users.

OSRI focuses on applied research and looks for tangible product results, such as Environmental Sensitivity Index maps and workshop publications. OSRI's fellowship program supports three to four students each year whose research will contribute to increasing that fundamental knowledge base necessary to effectively respond to oil spills. In future years, OSRI will continue to build partnerships with other non-profits, industry and agencies to both extend its limited budget and ensure that the issues and projects of most concern are addressed.

I encourage you to visit the new OSRI website at www.pws-osri.org, and send me your comments and suggestions.

Sincerely,

Nancy Bird
Director

OSRI Advisory Board Membership June 2003

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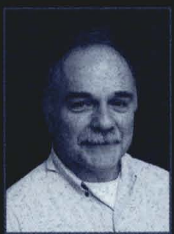

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National Marine Fisheries Service

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Our Mission & Goals

The purpose of the Prince William Sound Oil Spill Recovery Institute (OSRI) is to support research, educational projects and demonstration projects, all of which are designed to address oil spills in Arctic and sub-Arctic marine environments.

Authorized by Congress through the Oil Pollution Act of 1990 (and amendments passed in 1996 and 2002), the OSRI programs are determined by a 16-member Advisory Board with assistance from a Scientific and Technical Committee. The OSRI is administered through the Prince William Sound Science Center (PWSSC), a non-profit research organization founded in 1989 to facilitate and encourage ecosystem studies in the Greater Prince William Sound region.

Annual work plans are adopted by the OSRI Advisory Board, usually at their fall meeting held in September, and are based on four goals. The annual work plan determines the issuance of proposal solicitations. Proposals are accepted from individuals, organizations and businesses nationally and internationally. After peer review, award of proposals is determined by the Science Director in consultation with the Scientific and Technical Committee and, for proposals over $100,000, by the Advisory Board.

Understand

Attain a four-dimensional (meaning time and 3-dimensional space – x, y, z coordinates) interdisciplinary understanding of Prince William Sound to enable detection and prediction of spill-related impacts and subsequent recovery.

- Design Nowcast/Forecast observation and modeling system, demonstrate its utility, and seek long-term operational funding. (www.pwsoos.org)
- Conduct environmental research.
- Profile potential impacts on the economy, life-style and well-being of communities and resource users in Prince William Sound.

Respond

Enhance the ability of oil spill responders to mitigate impacts of spills in Arctic and sub-Arctic marine environments.

- Fill knowledge gaps on behavior of spilled oil.
- Fill knowledge gaps on use and effectiveness of specific mitigation techniques.
- Identify and evaluate new prevention and response technologies.

Inform

Disseminate information and educate the public on the issues of oil spill prevention, response and impacts.

- Publish scientific and technical results in the open literature.
- Brief oil spill responders on OSRI products and assist to include them in operational activities.
- Facilitate the exchange of information and ideas.
- Provide graduate and undergraduate fellowships and internships.

Partner

Partner with other organizations to take advantage of pooled funding, facilities, knowledge and experience.

- Collaborate with other partners in achieving a long-term coastal and ocean observing system for Alaska.
- Coordinate with the efforts of other related programs, such as the Gulf Ecosystem Monitoring (GEM) program and programs of the North Pacific Research Board (NPRB).

History

In Alaska, 1989 is remembered as the year of the Exxon Valdez oil spill. In the science world, it was two years later, 1991, that an international group of marine scientists identified a need to understand how global change affects the abundance, diversity and productivity of marine populations. They concluded that our ability to predict natural changes in marine animal population is very limited and initiated the GLOBEC (Global Ocean Ecosystem Dynamics) program. GLOBEC aims to advance our knowledge of the structure and functioning of the world's oceans and the ocean's response to physical forcing. It identifies the development of numerical models that assimilate real-time environmental information to nowcast and forecast natural physical and biological conditions. These models will improve our ability to predict marine animal population change, and that predictive ability is a prerequisite for assessing anthropogenic impacts such an oil spill on marine ecosystems. In turn, improved predictive abilities will result in much more effective oil spill prevention and response strategies.

The Prince William Sound (PWS) Oil Spill Recovery Institute (OSRI) was authorized by the United States Congress through Title V of the Oil Pollution Act of 1990. Between 1992 and 1995, Congress appropriated $500,000 to OSRI. Since 1996, when amendments instituted a funding mechanism for OSRI, the program has received annual interest earnings from a $22.5 million trust held by the U.S. Treasury. In 2002, Congress again amended OPA90 to extend OSRI's program through the 2012.

OSRI published its first strategic plan for oil pollution research and development in 1995 (Thomas et al. 1995). This plan divided oil spill problems into the risk of a spill and the costs of a spill (response and damage). Recognizing GLOBEC's conclusions about our weak ability to make physical and biological predictions, and the consequential impact on our understanding of damages caused by oil spills, the OSRI program incorporates GLOBEC's goals and approach to improve prediction of natural changes. This approach also improves our assessment of costs, a key element in identifying the best oil spill prevention and response technologies.

At a 1997 workshop hosted by OSRI to review its oil spill R&D plans, the Sound Ecosystem Assessment (SEA) research program was featured as an application of GLOBEC goals to the PWS region. SEA investigators presented descriptions of new tools to predict changes in circulation and physical conditions, plankton production and selected fish populations in the Sound. The prototype models demonstrated by the SEA program represented potential tools for OSRI to develop and use to identify best techniques for oil spill prevention and response.

Since 1998, OSRI has awarded an annual average of $1 million supporting a wide range of projects. The primary focus of many OSRI-funded projects is to build a nowcast-forecast system in Prince William Sound and contribute to improving our prediction of marine ecosystem changes. OSRI promotes team-research that includes researchers, users and managers and a multi-disciplinary approach that includes physicists, biologists and technologists.

Prior to 2003, the OSRI work plan categorized projects into three program areas (technology, ecology and education) and the Advisory Board promoted a goal of allocating funding among the three areas on a 40:40:20 ratio.

In 2002, the Board solicited a program assessment by the National Academies' Polar Research Board (PRB). In response to the PRB report, published in early 2003, the OSRI Advisory Board deleted the three program areas, revised its Strategic Plan and adopted four goals summarized as understand, respond, inform and partner.

APPLIED TECHNOLOGY

Nowcast/Forecast System for Ocean Circulation and Surface Winds: Numerical Modeling*

The numerical ocean circulation model – based on the Princeton Ocean Model (POM) - is at the center of the Prince William Sound Nowcast/Forecast System (NFS). The overall goal is to develop a predictive capability for estimating the currents and temperature and salinity structure of Prince William Sound in near real-time. The Prince William Sound POM was validated using historical data from the Sound Ecosystem Assessment (SEA) program and the University of Alaska Fairbanks' Institute of Marine Science. It is forced by near real-time measurements of winds and sea level and by monthly means of surface heat flux and throughflow at Hinchinbrook Entrance. The model is capable of producing animated current, temperature and salinity maps, animated particle trajectories, and transects of temperature, salinity and currents. Results are archived and are available on a website. A working first-generation system has been demonstrated.

The ocean circulation model has been linked with the SINTEF Oil Spill Contingency and Response (OSCAR) chemical fates visualization model. A meso-scale atmospheric model is being developed which will be linked with the ocean circulation model. Future plans also include linking the ocean circulation model with a biological nutrient plankton zooplankton detritus (NPZD) model.

*See following section re "Meso-scale Atmospheric Modeling"

2001 Grant Award

- *University of Miami-Rosenstiel School of Marine and Atmospheric Science, Miami, Florida $150,000*

2002 Grant Award

- *University of Miami-Rosenstiel School of Marine and Atmospheric Science, Miami, Florida $150,000*

Participants at the Nowcast/Forecast System workshop, June 2003, included representatives of ocean observing systems in Maine, Texas and Oregon.

Meso-scale Atmospheric Modeling with Nowcast/Forecast Capability for Prince William Sound

The objective of this project is to develop a high-resolution numerical weather simulation/prediction system for the Prince William Sound region. At the heart of this system is the Regional Atmospheric Modeling System (RAMS), a multi-purpose numerical prediction model. The proposed modeling system uses real-time observational data sets and large-scale forecast model data obtained from the National Weather Service and some other sources to build initial and boundary conditions for RAMS simulations. The RAMS forecasts are available in the form of graphical products on the Alaska Experimental Forecast Facility web page. Gridded data sets are also available for use by researchers. This atmospheric model is linked with the ocean circulation model for Prince William Sound.

2002 Grant Award
- *University of Alaska, Anchorage, Alaska $114,816*

Prince William Sound Tide Height & Meteorological Data Collection

This project provides for the installation and for the ongoing operation and maintenance of telemetered and automated tide gauges and meteorological data collection stations within Prince William Sound. During the summer and early fall of 2002, tide stations were installed at Grass Island on the Copper River Delta, Pigot Point, Tatitlek and Chenega Bay. Meteorological stations were installed at Grass Island, Tripod Hill (Cordova), Pigot Point, Tatitlek, Chenega Bay, and Nuchek. This information is used for multiple purposes; as part of the OSRI Nowcast Forecast effort, the meteorological data will be utilized in forcing and validating models (atmospheric and oceanographic) and as data sets for use in ecological research efforts, to provide information on environmental conditions to increase safety of navigation, for operational support in the event of a spill, and as a resource for improving local climatological predictions. This project is part of a larger effort to expand the comprehensive physical dataset available to researchers, the general public and oil spill responders. Numerous cooperators and partners are contributing in-kind services to this project including the Chugach School District, G.W. Scientific, Chenega Bay, Tatitlek and Nuchek, and the U.S. Coast Guard.

2001 Grant Awards
- *G.W. Scientific, Fairbanks, Alaska $129,280 (Note: Includes $20,000 matching grant from the State of Alaska for the Grass Island site)*
- *Prince William Sound Science Center $3,500 (calibration costs for SeaCat instruments)*

2002 Grant Award
- *G.W. Scientific, Fairbanks, Alaska $30,000*

Mechanical Oil Recovery in Ice Infested Waters (MORICE)

Initiated in 1995, this multi-phase program develops technologies for the effective recovery of spilled oil in ice-infested waters. MORICE is a multi-national effort involving researchers from Norway, Canada, Germany and the United States. The first two phases of the program included literature reviews, and qualitative laboratory testing. Two prototype systems were developed during the third phase of the project. These included a lifting grated belt and a brush-drum system. OSRI became a partner during the fourth phase in which design work and field-testing of the equipment were carried out. The fourth phase also included designing a working platform to incorporate the ice processing and oil recovery components. The fifth phase focused on testing of modifications to the components that did not perform well during phase 4. OSRI continued funding for phase 6 of this project in FY01 and FY02. Phase 6 includes full-scale testing of the oil recovery system developed by MORICE at the OHMSETT facility in Leonardo, Virginia.

2001 Grant Award

- *SINTEF Applied Chemistry, Trondheim, Norway $80,000*

2002 Grant Award

- *Minerals Management Service, $35,000*

Oceanographer Shari Vaughan prepares a drifter buoy for deployment.

Implementation of RESPONSE Software for Managing Oil Spill Logistics

This project supports installation at all of the state's oil spill cooperatives of RESPONSE software for managing oil spill logistics. The RESPONSE system, developed by E.A. Renfroe, was chosen as the software system to be utilized by the Alaska Statewide Oil Spill Response Resource Database. The establishment, operation and maintenance of the Alaska Statewide Oil Spill Response Resource Database is governed by a cooperative agreement among the following organizations:

- Prince William Sound Oil Recovery Institute
- Alaska Clean Seas
- Alaska Chadux Corporation
- Cook Inlet Spill Prevention and Response, Inc (CISPRI)
- Southeast Alaska Petroleum Resource Organization (SEAPRO)
- Alyeska Ship Escort Response Vessel Systems
- E.A. Renfroe & Co.
- U.S. Coast Guard, Seventeenth District
- U.S. Environmental Protection Agency (Region 10, Alaska Operations Office)
- Alaska Department of Environmental Conservation
- U.S. Navy Supervisor of Salvage

2001 Grant Award

- *SEAPRO, Ketchikan, Alaska $60,633*
- *Alaska Chadux Corporation, Anchorage, Alaska $59,833*
- *CISPRI, Nikiski, Alaska $60,633*

Oil Spill Response and Prevention Transponder System for the State of Alaska

This project examines the potential for establishing a reliable transponder system for vessels operating within the state of Alaska and suitable for operations in the higher latitude regions of Alaska and in harsh weather conditions. The equipment must be suitable for installation and operation on all vessels, including smaller fishing vessels. It must have the capability to transmit vessel identification, location, type and size, in addition to meteorological data collected by vessels, to the appropriate agencies, the oil spill response community and the public.

2001 Grant Award

- *Marine Exchange of Alaska, Juneau, Alaska $24,995*

Evaluation of Anchor Systems used in Geographic Response Strategies:

This investigation built and tested various anchor systems for use in the Kachemak Bay Geographic Response Strategies (GRS) area. These anchor systems are for placement during an oil spill of floating oil boom to exclude or divert floating oil from a selected area. Nine sites within the Kachemak Bay GRS region were noted as requiring large anchor systems. The anchor systems developed through this project were to be left in Homer for use in spill response training and during actual spill events.

2002 Grant Award

- *Cook Inlet Spill Prevention & Response, Inc. $6,160*

Ice Detection Project

Cook Inlet and Prince William Sound are home to major marine ports, petroleum development, large-scale commercial fisheries, cruise ship activities, and spectacular natural resources. However, ice in the traffic lanes can impair safe and efficient navigation. The ability for real-time ice detection in shipping lanes would reduce the risk of oil outflow from tankers. This joint project was developed by a multi-stakeholder working group and includes the installation of a conventional radar system at Reef Island in Prince William Sound. The installation will provide real-time monitoring of ice conditions to enhance control of vessel movements by USCG Vessel Traffic System in Valdez, Alaska. The installation on Reef Island will operate for a five-year period and will provide a platform for Phase II of the UHF radar tests and other research and development to further enhance ice detection capabilities. Making the marine transportation system safer, and thereby reducing the likelihood of spills, is the most effective measure for reducing oil spill consequences.

2001 Grant Award

PWS Regional Citizens' Advisory Council, Valdez, Alaska $100,000

PREDICTIVE ECOLOGY

Nowcast/Forecast System for PWS Ocean Circulation and Surface Winds: Observational Oceanography*

Observations of currents, temperatures and salinity in Prince William Sound are collected seasonally on oceanographic cruises as part of the nowcast/forecast system (NFS). These observations insure that the nowcasts and forecasts made by the numerical calculation model accurately represent the physical conditions in PWS. Research cruises for data collection are conducted about four times each year. Measurements of currents, temperature, and salinity are collected over all depths in the central basin of PWS and at Hinchinbrook Entrance. The analyzed data are used to create maps and sections of currents, temperature and salinity for comparison with the circulation model output. The Alyeska Ship Escort Response Vessel System (SERVS) donates ship time for these oceanographic cruises. Future plans include expanding the survey area to western PWS, and deploying satellite tracked drifting buoys for continuous sampling of near-surface currents throughout the year.

The numerical ocean circulation model is forced by actual measurements of physical variables. Some measurements are available in near real-time (e.g., winds, sea level) and some (e.g., surface heat flux, throughflow at Hinchinbrook Entrance) are obtained from previously analyzed data sets. The NFS Observational Oceanography component expanded in 2002 to include near real-time measurements of more variables and more locations in PWS through OSRI funding support in FY02 for drifting buoys, coastal tide gauges, and additional meteorological stations. Additionally, work is proceeding to developing links with other research groups (i.e. GLOBEC) and with operational groups (i.e. NWS, NOAA, USCG) to sustain the NFS.

See also "Applied Technology" section.

2001 Grant Award

- *Prince William Sound Science Center, Cordova, AK $150,000*

2002 Grant Award

- *Prince William Sound Science Center, Cordova, AK $150,000*

Biological Monitoring of Intertidal Resources at Risk to Oil Spills: Monitoring of Marine Invertebrates in Relation to Shorebird Use on the Copper River Delta

This project characterizes the spatial and temporal patterns of intertidal marine invertebrates on the mud flats of the Copper River Delta. The 2001 research program focused on shorebird-benthic invertebrate interactions, and also executed a number of experiments designed to examine predation. In 2002 the primary focus shifted to demersal predators-benthic invertebrate intereactions. Field work included the collection of several hundred invertebrate core samples and small otter trawl tows to collect bottom fish and crabs. Both the invertebrate and bottom fish collections represent the first time these communities have been sampled on the Copper River Delta. Other aspects of the study include primary production and nutrient measurements and stable isotope analysis performed to more accurately characterize the food web of the Delta.

2001 Grant Award

- *Prince William Sound Science Center, Cordova, Alaska $80,215*
- *University of North Carolina at Chapel Hill, Morehead City, North Carolina $19,785*

2002 Grant Award

- *Prince William Sound Science Center, Cordova, Alaska $76,681*
- *University of North Carolina at Chapel Hill, Morehead City, North Carolina $23,310*

Shorebirds depend on the rich resources of the Copper River Delta for refueling during their annual migration.

Remote Sensing Using Lidar

This project will test the effectiveness of lidar to survey herring and marine mammal populations and to monitor returning salmon in the Copper River. If it proves effective, it may be adopted as a management tool for Prince William Sound and the Copper River. The flights in PWS will be coordinated from surface surveys using acoustics, infrared imagery, and sampling. Investigations will include whether fixed wing aircraft rather than helicopters are effective for conducting the surveys, to what depths and in what water conditions the lidar is effective, and whether marine mammals in the vicinity of herring schools at night can be detected.

In the Copper River, a smaller effort will be focused on developing a tool for monitoring returning salmon. The shallowness and turbidity of the water in the delta region renders traditional acoustic and video methods fairly ineffective. The performance of both lidar and low-frequency acoustics will be evaluated.

2001 Grant Award

- *NOAA Environmental Technology Lab, Boulder, Colorado $100,000*

2002 Grant Award

- *NOAA Environmental Technology Lab, Boulder, Colorado $100,000*

Biological Monitoring of Herring and Pollock in Prince William Sound

During February and March of 2001 and 2002, herring and pollock biomass were estimated using scientific acoustic equipment. This is a cooperative project with ADF&G. Both ADF&G vessels and locally-charted fishing vessels were used on the surveys. Survey areas were determined using all available aerial, vessel and historic data. Acoustic data were collected using a current model echo sounder with a GPS receiver, a downward-looking transducer within a towed body and a computer hardware and software onboard the vessel. The acoustic data were converted into estimates of fish density and biomass within each of the sample areas.

2001 Grant Award

- *Prince William Sound Science Center, Cordova, Alaska $75,000*

2002 Grant Award

- *Prince William Sound Science Center, Cordova, Alaska $75,000*

Biological Monitoring of Spring Zooplankton and Nekton

In the springs of 2001 and 2002, the biomass of zooplankton and nekton were estimated using scientific acoustic equipment. Acoustic data were collected using echo sounders operating at 38, 120 and 420 kHz with a GPS receiver. Three PWS-wide surveys were conducted each year. Zooplankton composition was determined using plankton nets. The surveys were conducted aboard the SERVS vessel, Valdez Star. This is a cooperative project with the Alaska Department of Fish & Game and Prince William Sound Aquaculture Corporation.

2001 Grant Award

- *Prince William Sound Science Center, Cordova, Alaska $75,000*

2002 Grant Award

- *Prince William Sound Science Center, Cordova, Alaska $75,000*

Oil tankers use the Knowles Head anchorage while waiting to load at the Alyeska terminal in Valdez.

Environmental Sensitivity Mapping: Southeast Alaska

The goal of this project is to complete and produce Environmental Sensitivity Index (ESI) Shoreline Habitat Classification maps begun by NOAA in 1992, as well as update and prepare new biological resource maps for specific areas in Southeast Alaska following the existing format of NOAA maps already delivered. Shoreline habitat classification, including designation of certain human use features and database production, will be conducted for the incomplete coastal areas of the USGS quads. New and updated resource maps will be produced for additional areas.

2001 Grant Award

- *SEAPRO, Ketchikan, Alaska, $20,000.*

Environmental Sensitivity Mapping: Coastal Northwest Alaska

The purpose of this multi-year, cooperative project is to develop environmental sensitivity index (ESI) maps, including geographic information system (GIS) digital databases of the entire Alaskan coast. In 2001, the project focused on the Northwest Alaska coastal area, highlighting biological habitats and life stages, wildlife concentrations, shoreline geomorphology/sensitivity, and human-use resources, all of which are particularly sensitive to oil spills. NOAA leads this project. In 2002, the project focused on the Yukon-Kuskokwin Delta region. The information will be rendered into poster-sized maps on a 1:250,000 scale to correspond with the USGS quads. There will also be digital products consisting of an electronic map image, GIS data and GIS digital files.

2001 Grant Award

- *National Oceanic & Atmospheric Administration, Seattle, Washington $60,000*

2002 Grant Award

- *National Oceanic & Atmospheric Administration, Seattle, Washington $60,000*

PUBLIC EDUCATION & OUTREACH PROGRAM

Science of The Sound

This is an ongoing educational program that provides quality, formal and informal science programs to the communities of Prince William Sound. The program includes the Discovery Room science enrichment program for children in grades K-6, and the Summer Science Camp for middle school and high school age children.

2001 Grant Award
- *Prince William Sound Science Center, Cordova, Alaska $28,000*

2002 Grant Award
- *Prince William Sound Science Center, Cordova, Alaska $24,000*

Campers explore the intertidal zones on the beaches near Cordova.

Peer Listener Trainer Video

This project will assist Alaskan communities in preparing for the socio-economic impacts of a major technological disaster. The goal of the project is to develop a high quality, effective, video training series based upon one of the mitigation strategies (peer listening) as described in the guidebook "Coping with Technological Disasters". The OSRI grant will assist in funding production costs for this video.

2001 Grant Award
PWS Regional Citizens' Advisory Council, Valdez, Alaska $10,000

Oil Spill Response Standards/Protocols for Wildlife

The purpose of this project is to organize and conduct a workshop to develop draft national standards/protocols (i.e. husbandry, veterinary care, and training/certification of personnel) to prevent oiling of migratory birds, and for capturing, stabilizing and treating oiled migratory birds.

2001 Grant Award
- *Production Plus, Anchorage, Alaska $21,222*
- *Participant travel costs: $8,000*

Research and Development Priorities: Oil and Ice

The first objective of this project is to identify the critical deficiencies in the current state of knowledge concerning all aspects of oil spill response in ice-covered waters. The starting point will be a review of all papers presented at the International Oil and Ice Workshop held in April 2000 in Anchorage, Alaska. Priorities will then be assigned to specific research and development efforts that could be taken to address these deficiencies. The overall intent will be to produce a document that can be used to improve the future research and development efforts in the areas of arctic oil spill prevention and response.

2001 Grant Award

- *DF Dickins Associates, Ltd., Escondido, California $12,400*

Dialogue on Alaska

This project provided tuition support for a weekend retreat organized by the Institute of the North and focused on Alaska's future.

- *Institute of the North $3,000*

Environmental Educators of Southcentral Alaska Workshop

This purpose of this project is to organize and oversee the facilitation of a workshop for science and environmental educators in Anchorage, Alaska during April 2001. The goal of the workshop is to plan and begin implementation of a regional education program that will enhance citizens' appreciation for the ecosystem around them. The workshop will include a focus on oil pollution prevention and response educational issues.

2001 Grant Award

- *Alaska Natural Resources and Outdoor Education Association, Anchorage, Alaska $11,845*
- *Participant travel: $8,000*

The Orca Project

This project stems from the stranding and subsequent death of a killer whale at Hartney Bay in Cordova. The initial effort of this project will be to rearticulate the Orca skeleton with community and student volunteers. The next step will be to design and assemble an interpretive display that will enhance community and public understanding of marine mammals, habitat and conservation, and oil spill prevention. The final display of the Orca skeleton will be incorporated into local, sustainable environmental education curriculums.

2001 Grant Award

- *The Native Village of Eyak, $10,196*

From the Forest to the Sea

This project supports a residential science summer camp that is jointly conducted by the Prince William Sound Science Center and the U.S. Forest Service. Located on the Copper River Delta, the camp is attended by children ages 7-14 from throughout Alaska.

2002 Grant Award

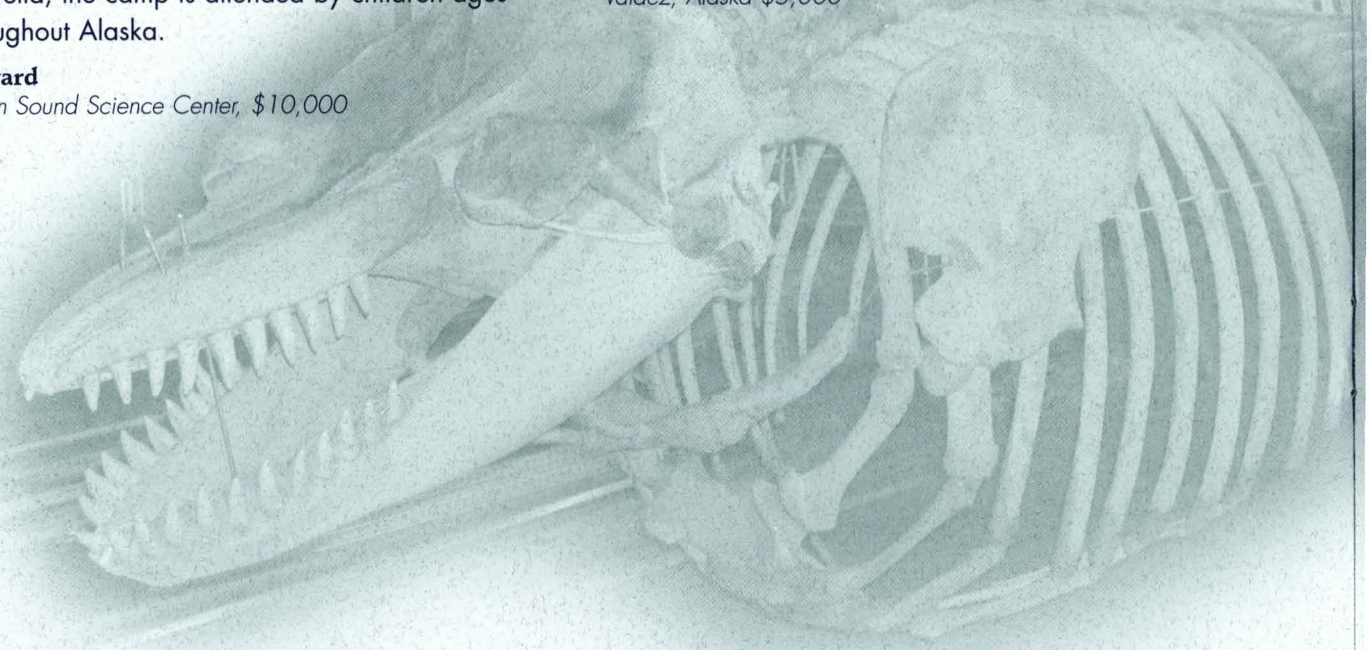
- *Prince William Sound Science Center, $10,000*

Trans-Alaska Pipeline Review

The Alaska Department of Environmental Conservation (ADEC) initiated a public review of the Alyeska Trans-Alaska Pipeline Plan to ensure that adequate oil spill prevention and response capabilities are in place to protect the sensitive environments of Prince William Sound and the portion of the Gulf of Alaska related to the Copper River and the Lowe River drainages. The Prince William Sound Regional Citizens' Advisory Council (RCAC) conducted a thorough review of the plan, focusing particularly on the Copper and Lowe River drainages. OSRI supported this review as part of its educational efforts to inform regional residents about oil spill prevention and response capabilities. The RCAC review document was made available RCAC member organizations and others, on request. It included recommendations for improvements in the prevention and response system.

2001 Grant Award

- *PWS Regional Citizens' Advisory Council, Valdez, Alaska $5,000*



The Native Village of Eyak, U.S. Forest Service and PWS Science Center/OSRI collaborated in re-articulating the skeleton from a beached orca named Eyak.

Oil Dispersion Analysis Workshop

This multi-year project is to examine the relative impacts of various spill response methods and technologies within Prince William Sound. The effort will use the best available modeling techniques for estimating the net environmental effects of alternate responses to specific spills. The project is designed to involve as many stakeholders as are willing to participate. A series of public meetings and scientific panels are to be scheduled through which the modeling efforts and the issues surrounding the impacts of dispersant use can be assessed by the stakeholders and decision makers of the region.

In 2002, OSRI solicited proposals for a facilitator to conduct the first workshop of the series designed to introduce the project to stakeholders and determine their interest in participation and the next steps in the process.

2002 Grant Award

- *Don Aurand, Ecosystem Management & Associates, Inc. $5,485*
- *Lisa O'Brien, Alaska Training & Consulting; and Hilary Hardwick, Production Plus $6,500*

Intensive Observation Periods (IOP) Workshop

This workshop brought modelers, oceanographers and others with oceanographic data collection expertise together to review active studies and near future plans of ongoing observational and modeling studies of the oceanic circulation of Prince William Sound and the adjacent Alaska Shelf. The workshop goal was to develop scientific goals and objectives, and outline a program of long-term observations and IOPs as a cooperative research project over a five-year period. IOPs are purposeful process studies and experiments of limited duration but include substantial enhancement of sensing systems and platforms.

2002 Grant Award

- *Rosentiel School of Marine and Atmospheric Science, University of Miami, $40,315*

Office and lab facilities of the OSRI and PWS Science Center are at the entrance to Cordova's boat harbor.

Development of FY00 Annual Report

A grant was awarded for compilation, publishing and distribution of the FY00 Annual Report for the Prince William Sound Oil Spill Recovery Institute. This included all design work, preparation, artwork, printing and distribution.

2001 Grant Award

- *Jumping Mouse Productions, Cordova, Alaska $12,000*

Newsletters

A grant was awarded for compilation, publishing and distribution of two four-page newsletters for the Prince William Sound Oil Spill Recovery Institute. This included all design work, preparation, artwork, printing and distribution.

2001 Grant Award

- *Jumping Mouse Productions, Cordova, Alaska $9,600*

FELLOWSHIPS

Switgard Duesterloh

School of Fisheries and Ocean Sciences, University of Alaska, Juneau. Duesterloh is a doctoral student whose thesis focuses on how petroleum hydrocarbons affect zooplankton in different seasons of the year.

2001 Fellowship award: $25,906
2002 Fellowship Award: $18,000

Sean P. Powers

University of North Carolina at Chapel Hill, Chapel Hill, North Carolina. Dr. Powers is a post-doctoral fellow whose research monitors inter-tidal marine invertebrates used by shorebirds of the Copper River Delta. Powers works with principal investigators Dr. Mary Anne Bishop and Dr. Charles Peterson.

2001 Fellowship Award: $25,000
2002 Fellowship Award: 25,000

Fellowship doctoral student Switgard Duesterloh on a research cruise in Prince William Sound.

John Ash

Scott Polar Institute, University of Cambridge, England. Ash is a doctoral student whose work focuses on the management of environmental risk associated with the development of oil on the Alaskan Arctic littoral.

2001 Fellowship Award: $24,500

Heidi Hansen

University of Wyoming. Hansen is a Masters degree student under Dr. Merav Ben-David. Hansen's research topic addresses DNA typing of river otters in Prince William Sound.

2002 Fellowship Award: $24,235

Zinglong Wu

Rosentiel School of Marine & Atmospheric Science, University of Miami. Wu is a pre-doctoral student studying oceanographic modeling under Dr. Christopher N.K. Mooers. His present research addresses issues with boundary conditions for the development and implementation of an extended domain Princeton Ocean Model for Prince William Sound.

2002 Fellowship Award: $24,500

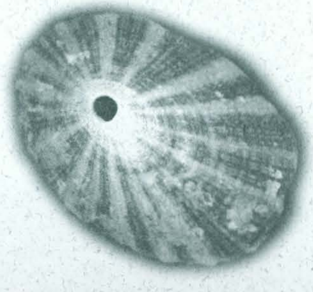
OTHER

Review of the Oil Spill Recovery Institute's Arctic and Subarctic Research Program

The Polar Research Board of the National Academies of Science conducted a review of the research program and technology development activities of the Oil Spill Recovery Institute (OSRI). The purpose of this review was to explore whether the research and activities to date address the OSRI mission statement; to assess whether the research and activities are of good quality, effective and efficient; to determine whether the grant award process is sound; to consider whether existing planning documents set an appropriate course for the future; to offer recommendations for future directions; and, to comment, if possible, on mechanisms to increase responses to OSRI's calls for proposals.

2001 Grant Award

- *Polar Research Board, National Academies, Washington, D.C. $100,000*



FINANCIALS

Funds for the Oil Spill Recovery Institute were authorized by the United States Congress through the Oil Pollution Act of 1990 (OPA'90) and amending legislation passed in 1996. The Prince William Sound (PWS) Science Center, a non-profit research and education institution in Cordova, Alaska, administers the OSRI programs as directed by OSRI's Advisory Board.

The PWS Science Center receives the interest earnings from a $22.5 million trust held by the U.S. Treasury and dedicated to finance the OSRI programs. The interest earnings equal about $1 million per year and will continue through the federal fiscal year 2012. The original source of the $22.5 million trust fund was the Trans-Alaska Pipeline System (TAPS) fund which is now part of the National Oil Spill Liability Trust Fund.

The following pages include the Statements of Financial Position for the Prince William Sound Science Center and the Financial Position and Statement of Activities related to OSRI programs for the fiscal years 2001 and 2002.

Professional audits of the PWS Science Center's financial records, including the OSRI program fund, are completed annually by a nationally recognized accounting firm. The FY01 audit was completed by KMPG and Mikundra Cottrell completed the most recent audit for FY02. Copies of the audited financial statements are available on request to Penelope Oswalt, Finance Director, PWS Science Center, P.O. Box 705, Cordova, AK 99574, or e-mail penya@pwssc.gen.ak.us.

Summary of OSRI program expenditures FY01 and FY02

Program Areas	**FY01**	**FY02**
Administration	272,381	254,349
Applied Technology	521,729	602,136
Predictive Ecology	573,272	689,297
Public Education & Outreach	248,355	173,779
Other Programs	0	125,716
TOTALS	$ 1,845,277	$ 1,615,737

PRINCE WILLIAM SOUND SCIENCE AND TECHNOLOGY INSTITUTE

(d.b.a. Prince William Sound Science Center)

Statement of Financial Position
Including the Oil Spill Recovery Institute
September 20, 2002 and 2001

		General Fund	Plant Fund	Program Funds	Totals 2002	Totals 2001
Assets:						
Cash	$	31,396	-	197,149	228,545	146,527
Accounts receivable		57,419	-	-	57,419	135,261
Investments		-	-	2,754,888	2,754,888	3,420,289
Accrued interest receivable		-	-	30,252	30,252	9,928
Grants receivable		-	-	575,003	575,003	756,633
Prepaids and other assets		55,749	-	-	55,749	44,636
Other receivables		1,574	-	-	1,574	2,102
Due from other funds		222,834	-	169,887	392,721	423,307
Leasehold		145,500	-	-	145,500	163,500
Property and equipment, net of accumulated depreciation		-	208,897	-	208,897	202,815
Total assets	$	514,472	208,897	3,727,179	4,450,548	5,304,998
Liabilities:						
Accounts payable	$	6,625	-	-	6,625	164,988
Wages, taxes and benefits payable		190,623	-	-	190,623	179,648
Deferred revenue		-	-	2,384,785	2,384,785	3,269,221
Due to other funds		169,887	-	222,834	392,721	423,307
Total liabilities		367,135	-	2,607,619	2,974,754	4,037,164
Net assets:						
Temporarily restricted		145,500	-	-	145,500	163,500
Unrestricted		1,837	208,897	1,119,560	1,330,294	1,104,334
Total net assets		147,337	208,897	1,119,560	1,475,794	1,267,834
Total liabilities & net assets	$	514,472	208,897	3,727,179	4,450,548	5,304,998

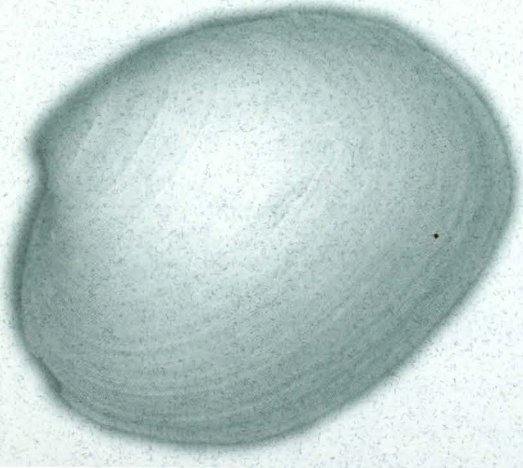
PRINCE WILLIAM SOUND SCIENCE AND TECHNOLOGY INSTITUTE

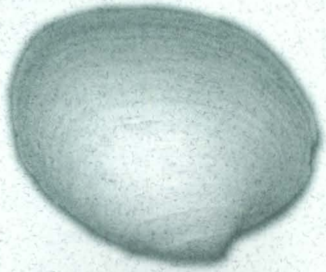
(d.b.a. Prince William Sound Science Center)

Oil Spill Recovery Institute (OSRI) Programs Combining Statement of Financial Position

Years ended September 30, 2002 and 2001

		OSRI 2002	OSRI 2001
Assets:			
Cash	$	197,149	146,527
Accounts receivable		—	89,079
Investments		2,754,888	3,420,289
Accrued interest receivable		30,252	9,928
Due from other funds		156,388	64,324
Grants receivable		352,169	416,493
Total assets	$	3,490,846	4,146,640
Liabilities - deferred revenue	$	2,371,286	3,250,378
Unrestricted net assets		1,119,560	896,262
Total liabilities and unrestricted net assets	$	3,490,846	4,146,640





Oil Spill Recovery Institute (OSRI) Programs Combining Statement of Activities

Year Ended September 30, 2002 and 2001

		Consolidated OSRI 2002	Consolidated OSRI 2001
Changes in unrestricted net assets:			
Revenues:			
Grants and contributions - Federal	$	1,901,309	1,635,140
Interest		153,090	143,330
Unrealized gains on investments		70,208	88,883
Total revenues	$	2,124,607	1,867,353
Expenses:			
Salaries and benefits		489,931	552,414
Supplies		36,345	7,984
Professional services		8,430	10,735
Subcontracts and charter costs		18,979	48,234
Telephone		22,423	27,135
Utilities		6,566	6,000
Insurance		2,517	2,123
Advertising		822	167
Postage and freight		1,686	3,165
Printing, publications and copying		3,966	5,632
Equipment maintenance		1,970	2,406
Facilities and equipment rent		9,172	250
Other		6,084	2,213
Travel		65,955	35,324
Equipment		-	(96)
Grants awarded		1,113,272	835,980
Total expenses before interfund facility and equipment costs and indirect costs		1,788,118	1,539,666
Interfund facility and equipment costs		13,140	13,140
Indirect costs		81,903	77,819
Total expenses		1,883,161	1,630,625
Increase in unrestricted net assets		241,446	236,728
Net assets at beginning of year		896,262	664,049
Transfers to Plant Fund		(18,148)	(4,515)
Net assets at end of year	$	1,119,560	896,262

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What is AOOS?

The Alaska Ocean Observing System is part of a growing national network of integrated ocean observing systems that will improve our ability to rapidly detect changes in marine ecosystems and living resources, and predict future changes and their consequences for the public good. When fully developed, AOOS will

- Serve as the Alaska regional node for a national network of observing systems;
- Systematically deliver both real-time information and long-term trends about Alaska's ocean conditions and marine life;
- Provide to the public Internet access to cost-free data and information on coastal conditions; and
- Supply tailored products to meet the needs of mariners, scientists, industry, resource managers, educators, and other users of marine resources.

What kinds of oceanographic information?

AOOS will provide a centralized location for

- Data from platforms such as buoys, providing wind and current speed and direction, wave height, sea temperature and salinity, and more;
- Enhancements to existing NOAA weather buoy data for specialized local needs;
- Processed satellite data providing Alaska-wide information on sea-surface temperature, ocean color (chlorophyll) and wind;
- Geographically comprehensive surface current data from high frequency radar;
- Data about fish, birds and marine mammals, the environmental effects of human activities, and any other information that can be used with the physical data to predict future changes to the ocean ecosystem.

Why do we need this information?

The goals of the national Integrated Ocean Observing System are to

- Improve the safety and efficiency of marine operations;
- More effectively mitigate the effects of natural hazards;
- Improve predictions of climate change and its effects on coastal populations;
- Improve national security;
- Reduce public health risks;
- More effectively protect and restore healthy coastal marine ecosystems; and
- Enable the sustained use of marine resources.

Alaskans must help prioritize the goals for the Alaska regional system.

Don't we have this capability today?

We do not. Historically, government agencies have had the responsibility of gathering these observations, but the agencies have had neither sufficient funding nor discretion to mount comprehensive long-term collection efforts or tailor data collection to meet practical local needs. Hence, many observation and information gaps exist in Alaska. As uses of the marine environment increase, the broader, ecosystem-based decisions expected in the future will require more systematic, coordinated databases.

Who will use AOOS?

- Mariners, fishermen and subsistence users who daily must make decisions that affect their livelihood and safety;
- Search and rescue operations planning effective strategies to save lives;
- Scientists studying Alaska's ocean ecosystems;
- Coastal security operations ensuring the safety of Alaska's ports and waters;
- Resource managers seeking ways to use and sustain resources for the future;
- Educators seeking to convey the complexity and connectedness of Alaska's oceans; and
- All those who ply Alaska's oceans for their livelihood, subsistence or recreation.

Who will make this happen?

- Regionally, a partnership has been formed to promote development of a regional program in Alaska. Partners include the State of Alaska; federal agencies, such as the National Oceanic and Atmospheric Administration (NOAA) and the Department of Interior; academic institutions, including the University of Alaska; research organizations, such as the North Pacific Research Board, the Alaska SeaLife Center, the Prince William Sound Science Center, the Arctic Research Commission, and the Barrow Arctic Science Consortium; and industry groups, including fisheries and aquaculture associations.
- Nationally, the effort is being led by the Ocean.US Office under the National Oceanographic Partnership Program. Legislation creating the national system and associated regional systems has passed the U.S. Senate (S. 1400), calling for a $140 million commitment to ocean observing by 2006, with $50 million for regional efforts.
- Internationally, a Global Ocean Observing System (GOOS) steering committee is working to link U.S. national efforts to the existing global observation network.

What is being done in Alaska?

- Alaska is developing a functioning program in anticipation of funding for the national effort.
- The partners have committed two years of funding to plan for and develop AOOS. An office has been established in Anchorage and a director hired to facilitate development of the program.
- The partners have developed an interim governance structure, beginning with a Memorandum of Agreement.
- Potential users of AOOS – shippers, fishermen, subsistence harvesters, the oil industry, resource managers, and researchers – will review existing data collection, identify what priority needs are not being met, and develop pilot projects.
- A business plan for implementing AOOS and ensuring its long-term sustainability will be developed with the assistance of the University of Alaska.

Are You Interested in Serving as a Peer Reviewer?

The Gulf Ecosystem Monitoring (GEM) Program, Arctic Yukon Kuskokwim Sustainable Salmon Initiative (AYK SSI), and the North Pacific Research Board (NPRB) are seeking peer reviewers to update and enhance its database of scientific and technical reviewers. As you may know, our organizations rely on volunteer peer reviewers in scientific specialty areas to help insure the integrity of our programs, and to maximize the funds available to scientists for research and program implementation.

Your participation is important to our success and we highly value the time you contribute. If you fill out this form you will be contacted via e-mail with an online survey which will provide information to assist us in matching you to proposals which are in need of review. The survey will take a few minutes to fill out and will greatly assist us in utilizing your skills effectively and efficiently. In order to make performing technical reviews a less time consuming task, our programs limit the number of pages in a proposal and use online evaluation forms to streamline review submittals. We also strive to limit the number of reviews per evaluator and the number of requests to an individual per year.

Please fill out the fields below and mail/fax to:

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NAME: ______________________________

CONTACT NUMBER: ______________________________

EMAIL: ______________________________

Thank you for your consideration of our request. We appreciate your help.

Dr. Phil Mundy, Science Director
Gulf of Alaska Ecosystem Monitoring and Research Program

Dr. Clarence Pautzke, Executive Director
North Pacific Research Board

Dr. Joseph Spaeder, Staff
Arctic Yukon Kuskokwim Sustainable Salmon Initiative

Gulf Ecosystem Monitoring – www.oilspill.state.ak.us

Imagine a marine research program in one of the world's most productive ecosystems that had indefinite, guaranteed funding. This is the Gulf of Alaska Ecosystem Monitoring and Research (GEM) program, a long-term commitment to gathering information about the physical and biological components that make up a world-renowned marine ecosystem. What makes GEM unique is that it incorporates interagency cooperation and collaboration, public involvement and accessible, informative data and information on the Gulf of Alaska ecosystem.

North Pacific Research Board – www.nprb.org

The North Pacific Research Board (Board) was created by Congress in 1997 to recommend marine research initiatives to the U.S. Secretary of Commerce (Secretary), who is charged with making final funding decisions. The Board has 20 members hailing mainly from Alaska, Washington and Oregon. Its staff and home office are located in Anchorage, Alaska.

The Board's overall mission is to develop a comprehensive, high caliber, science program that provides better understanding of the North Pacific, Bering Sea, and Arctic Ocean ecosystems and their fisheries. Its work will be conducted through science planning, prioritization of pressing fishery management and ecosystem information needs, coordination and cooperation among research programs, competitive selection of research projects, enhanced information availability, and public involvement.

Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative-www.aykssi.org

The AYK SSI is a cooperative salmon research planning and funding initiative aimed at addressing the need for expanded research on declined salmon stocks in the AYK region. Through this initiative, native regional organizations have joined with state and federal agencies to form an innovative partnership to cooperatively address salmon research and restoration needs. This partnership includes the Association of Village Council Presidents (AVCP), the Tanana Chiefs Conference (TCC), Kawerak, Inc., Bering Sea Fishermen's Association (BSFA), Alaska Department of Fish and Game (ADF&G), National Marine Fisheries Service (NMFS), US Fish & Wildlife Service (USFWS), plus additional native, governmental and NGO ex-officio partner institutions. The purpose of the AYK SSI is to foster expanded fishery research in order to help understand the causes of the decline of these stocks and to support sustainable salmon management in the region. The Initiative will accomplish this through: 1.) funding high quality research projects addressing pressing fisheries information needs in the region, and; 2.) facilitating coordination and cooperation among research and management institutions by developing a dynamic, comprehensive, long range Research and Restoration Plan for the region.

2004 Marine Science Symposium
January 12-14, 2004

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